Simulating the Impact of Inflation on the Progressivity of Personal Income Tax in Brazil*

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Keywords: Income Tax; Inflation; Progressivity; Redistribution; Latin America, Brazil

JEL Code: H22; H23; C81.

Income tax reform in Brazil has mainly stressed changes in rates, aiming at increasing its progressivity. One aspect frequently overlooked is that, in the absence of adjustments of the tax rules to inflation, the level and distribution of the income tax burden can be substantially affected. We use a microsimulation model to simulate the potential revenue and distributive effects of inflation on the income tax in Brazil. Our findings suggest that if the income tax is not adjusted for inflation, progressivity would decrease but redistribution would increase due to a larger tax burden, but income inequality would not substantially change.

No Brasil, reformas do imposto de renda têm enfatizado mudanças nas alíquotas, objetivando o aumento de sua progressividade. Um aspecto frequentemente desconsiderado é que, na ausência de ajustamentos das regras do imposto em relação à inflação, o nível e distribuição da carga do imposto

*A previous version of this paper was presented at the 1st General Conference of the International Microsimulation Association, Celebrating 50 Years of Microsimulation, August 2007, Vienna, Austria, hosted by the European Centre for Social Welfare Policy and Research. We would like to the Editor for useful comments on earlier drafts of the paper. Responsibility for any remaining errors is ours alone.

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podem ser substancialmente afetados. Utilizamos um modelo de microssimulação para estimar os potenciais efeitos distributivos e arrecadatórios da inflação sobre o imposto de renda no Brasil. Os resultados sugerem que não ajustando o imposto de renda de acordo com a inflação, sua progressividade diminui e seu efeito distributivo aumenta. Entretanto, a desigualdade de renda não muda significativamente.

1. INTRODUCTION

Since 1997, when the government abolished the existing automatic adjustment of the income tax[1] schedule according to inflation, unions have pressed the government to readopt some regular indexing mechanism. However, the adjustments made in the last decade have been irregular. Only in 2007 a regular indexing regime was put in place, by which the income tax schedule is adjusted in accordance with the inflation target set by the Brazilian Central Bank. Thus, at the centre of the fiscal policy debate in Brazil are the effects of inflation on the personal income tax. A key issue involved is the distributional and revenue impact of the fiscal drag. This paper seeks to contribute to the debate by measuring the extent of that impact.

Few studies have attempted to analyze the distributive effect of the income tax in Brazil,[2] one main reason being the fact that the main data set used, the PNAD, does not contain direct information on income tax payments by individuals or families. To overcome this difficulty, we use a tax-benefit microsimulation model, BRAHMS, to investigate how inflation may affect the distributional features of the income tax in Brazil. This is done by simulating the amounts of income tax paid by individuals and families, using income and other relevant characteristics found in the micro data for Brazil. We take 2003 as the baseline. The analysis is performed for the period 2003-2008, with the nominal values of incomes and income tax parameters adjusted according to the inflation rate for each year.

Besides this introduction, the paper is divided in six sections. Section 2 gives some background information on the issue of income tax indexation in Brazil. Section 3 discusses the inflation-based distortions in the tax function induced by the presence of fiscal drags. Details about BRAHMS, the data used, the simulations performed, and the redistributive measures employed in the analysis are given in Section 4. Following on this, Section 5 reports the simulation of the distribution of income tax burden in Brazil and its progressivity for the 2003 baseline. In Section 6 we analyze how the impact of inflation on the nominal values of income tax payments affects the progressivity of the income tax. Finally, Section 7 presents the concluding remarks.

2. INCOME TAX INDEXATION AND INFLATION IN BRAZIL

Since the 1960s, when the government introduced an official mechanism of adjustment of monetary values known as *correção monetária*, Brazil has developed a large experience with indexation. For most policy analysts,[3] this process of generalized indexation gave rise, over the years, to a self-reproducing inflationary process that was at the root of the hyper-inflation of the 1980s and early 1990s.[4] It is thus not surprising that, after the successful economic stabilization plan enacted in 1994, policy makers have developed reluctance in resorting to statutory indexation.

[1] From now on, for convenience, we use the term income tax to refer to personal income tax.

[2] See, for example, Rocha (2002) and Hoffmann (2002).

[3] For instance, Franco (2004), Secretaria da Receita Federal (2001), Bresser-Pereira (1991) and Ramalho (2003)

[4] Some empirical results do not support the inertial inflation hypothesis (Durevall, 1999)

This is reflected in the absence of a regular inflation-adjustment scheme for the personal income tax in the last decade. In fact, for six years, from 1996 to 2001, there was no adjustment of thresholds in the income tax schedule. Mainly due to pressure from trade unions and taxpayers there was some irregular adjustment between 2001 and 2006. The mounting public reaction to the infrequent adjustment of the personal income tax has also led the government to announce that for the period 2007 to 2011 the schedule is to be adjusted according to the Central Bank inflation target for that period, which was set at 4.5%.

Yet tax authorities in Brazil have argued that, besides fuelling inflation, the use of an automatic adjustment mechanism for the personal income tax schedule further reduces the (already small) number of taxpayers and the tax base through increases in the exemption limit.[5]

They argue that this tend to have a negative impact both on tax revenue and on the *progressivity* of the personal income tax (Secretaria da Receita Federal, 2004).

On the other hand, taxpayers argue that the corrosive impact on disposable incomes, especially wages, of not adjusting the tax schedule by inflation is regressive. It is also frequent the perception among the population that irregular indexation has allowed the government to significantly increase income tax revenue.

Thus, there seems to be a conflicting view about the distributive and revenue effects of adjusting the income tax schedule by inflation between the Brazilian tax authorities and the general public. The former stressing the regressive impact of the adjustment and the potential revenue loss, the latter emphasizing the opposite view.

3. FISCAL DRAG AND DISTORTIONS OF THE TAX FUNCTION

Following Immervoll (2005), this paper focuses on the effect of inflation-induced distortions of the tax function.[6]

Let taxes t be a function of pre-tax income $y : t = t(y)$. Note that, while omitted here for convenience, other tax-relevant characteristics z (such as family structure or employment status) will generally enter the tax function. In a typical income tax system the tax function incorporates adjustments a applied to pre-tax income y to yield taxable income (e.g. in the form of deductions), the tax rate schedule $s(.)$ as well as tax credits c. Since both a and c may depend on y we have $t(y) = s(y - a(y)) - c(y)$. If not corrected, inflation erodes the real values of any nominally defined parameters of $s(.)$, $a(.)$ and $c(.)$. The erosion of tax-bracket limits is perhaps the most obvious effect. The two factors determining to which extent inflation alters the real tax burden levied on a given pre-tax income y are the rate of inflation and the shape of the tax function $t(.)$.

How will the erosion of the real value of tax function parameters affect household incomes? On a theoretical level, Immervoll (2005) has shown that, while inflation-induced erosions of tax credits will always reduce liability progressivity, the effect is ambiguous as far as the erosion of deductions and tax bracket limits are concerned. In addition, theoretical conclusions about how inflation might affect progressivity in a nominally defined tax system are more difficult to arrive at once c or a are functions of y(as is, for instance, the case if earnings-related social contribution payments are tax deductible). In these cases, the results would depend both on the functional forms of $c(y)$ and $a(y)$ and on whether and how these are distorted by inflation. In any case, if we are ultimately interested in how inflation affects the degree to which income taxes equalise net household incomes then results regarding liability progressivity are not sufficient. In addition one needs to know the size of tax burdens before inflation as well as the pattern of household sharing between tax units with different pre-tax incomes.

[5]The number of taxpayers in 2003 corresponded to about 6% of the economically active population (Secretaria da Receita Federal, 2004).

[6]For a detailed discussion on this and other channels through which changes in the general price level affect real tax burdens see, among others, Immervoll (2002), Immervoll (2005), Immervoll (2007), Feldstein (1997) and Feldstein (1999).

Earlier empirical studies suggest a regressive nature of fiscal drag in the sense that, in relative terms, tax burdens increase by more for low-income groups than for high-income taxpayers. There have been studies for Australia (Taxation Review Committee, 1974), Canada (Vukelich, 1972, Jarvis, 1977), the USA ((Goetz and Weber, 1971, Von Furstenberg, 1975, Sunley and Pechman, 1976) and Italy (Majocchi, 1976, Lugaresi and Nicola, 1991). These studies also show that, in a progressive tax system, average tax rates increase for all income groups and that any discretionary adjustments of the tax schedule have generally less than compensated for the effects of inflation.

In his study of three European countries (Germany, the Netherlands and the UK), Immervoll (2005) has provided micro-based analyses of the effects of inflation-induced tax-burden changes on the distribution of household incomes. He found that, even during times of low inflation, effects on tax burdens can be substantial if no regularly applied mechanism exists whereby tax and contribution rules are inflation-adjusted. For all three countries, an erosion of nominally defined tax parameters was found to reduce overall tax progressivity but, as a consequence of increasing overall tax liabilities, enhance the equalising properties of tax systems.

4. METHOD

4.1. Model and data

Our analysis uses BRAHMS, the Brazilian Household Microsimulation System.[7] BRAHMS is a tax-benefit model that calculates personal income tax, social insurance contributions, social benefits and disposable incomes for a representative sample of the Brazilian population. This is done by combining personal and household characteristics from each observation in the sample with detailed institutional information of the tax and benefit rules. The version of BRAHMS used here is 2003b. It relies on the data and the policy rules for the (baseline) year 2003.

Each tax and benefit is calculated in accordance to the legal system so that interactions between different policies are accounted for (e.g. tax deductibility of employees' social insurance contributions). Income components that are not simulated (such as market incomes or pensions) are taken directly from the data. Any tax deductions, allowances and other provisions that depend on income, family situations or other characteristics recorded in the underlying micro-data are taken into account in the simulations.

BRAHMS's version 2003b uses micro-data taken from the 2003 National Household Survey (*Pesquisa Nacional por Amostra de Domicílios* PNAD). PNAD is the main socio-economic household survey in Brazil. The 2003 sample consists of 133,255 households and 384,834 individuals. The survey provides detailed information on socio-demographic and labour market information relevant for calculating tax burdens and benefit entitlements. For example, the survey distinguishes between workers who are and are not registered in the social security system or affiliated to a trade union. This information is crucial for taking into account tax evasion and to determine the eligibility to insurance benefits.

4.2. Simulation

INCOME TAX SIMULATION

In order to account for the large number of informal workers, income taxes and contributions simulated in BRAHMS are only computed for individuals who are registered in the social security or affiliated to a trade union. All other individuals reporting employment or self-employment income are assumed to belong to the informal sector and pay no taxes.[8] In fact, over 90% of all personal income tax in Brazil

[7] For more details on BRAHMS, see Immervoll (2005) and Immervoll et al. (2006).

[8] According to Reis and Ulyssea (2005) about 50 percent of workers belong to the informal sector.

is withheld at the source, which presupposes a formal work relation. Simulated contributory benefits are also conditional on membership in the social security scheme.

In 2003, all residents were required to file income tax returns if their taxable income exceeded an exemption limit equivalent to 4.4 times the minimum wage (MW).[9] Taxable income includes earnings, property income, pensions and earnings-related contributory benefits.[10] Maintenance transfers, means-tested benefits and unemployment benefits are not subject to income tax. With a high degree of income inequality, a relatively generous exemption threshold, and the sizable informal sector, only about 6% of the economically active population pays income tax in Brazil

Personal income tax is levied at the individual level. However, taxpayers can also file jointly and benefit from a deduction (about 44% of MW) for each dependent relative.[11] There are also tax allowances for public and private insurance contributions,[12] education (about 70% of MW for each dependent relative), and medical expenses (subject to no limit), and for pensioners aged 65 or more of 4.4 MW. Alternatively, these itemised allowances can be replaced by a standard deduction equivalent to 20% of taxable income. The tax schedule consists of two bands. The marginal tax rate is 15% above the exemption limit and 27.5% for taxable income above twice the exemption limit.

Simulations in BRAHMS assume that individuals choose the tax and benefit options that maximise disposable income at the family level. Therefore, family members choose the taxation scheme (individual or joint) and tax allowances that minimise the income tax liability of the family.

Comparisons of BRAHMS output against a number of official "headline" statistics are shown in Table 1. In general, the estimates compare reasonably well with available reference figures. Observed deviations are in line with those found for tax-benefit models in other countries and attributable to the data limitations and assumptions described above.[13] More detailed validation-related data can be obtained from the authors on request.

INFLATION ADJUSTMENT SIMULATION

One of the key advantages of the microsimulation approach is its ability to analyse one type of change (e.g., policy rules, incomes, personal characteristics, etc) at a time while holding "everything else" constant.[14] In the present study, this allows us to focus on the effects of inflation on the tax system while keeping everything else constant (for example, changes in social contributions or in income due to other factors).

The effects of inflation on income tax are calculated by increasing all monetary variables in the micro-data in line with inflation, while using alternative hypotheses about inflation adjustment of income tax monetary parameters (e.g., thresholds in the tax schedule). In order to distinguish the effect on the income tax from that on other policies, all other simulated policies (i.e., benefits and social contributions) are also increased by inflation.[15] Changes in real tax burdens can then be computed as the arithmetic difference between the "before" ("baseline") and "after" inflation scenarios. The analysis

[9] To facilitate interpretation, monetary values are expressed as a proportion of the national minimum wage (MW). In 2003, the MW amounted to 240 *reais* per month, which corresponds to approximately 25% of the average wage. It is equivalent to US$ 129 in purchasing power parities.

[10] Investment income is subject to income tax, but withheld at the source and with different set of rates.

[11] These include spouses, children aged under 22 (or 25 when in education), and other relatives with taxable income below the exemption limit.

[12] Public insurance contributions are deducted in full while private insurance contributions are deducted up to 12% of taxable income.

[13] See, for example, the EUROMOD country reports on `http://www.iser.essex.ac.uk/msu/emod/countries/`.

[14] For an introduction to the microsimulation approach, see Redmond et al. (1998).

[15] Thus, the underlying assumption is that only income tax is not automatically and fully adjusted for inflation. In practice, social contribution brackets are annually readjusted according to inflation. As to benefits, some (like the minimum value of pensions, including assistance pensions, unemployment benefit, wage bonus, and annual bonus) are updated according to the variation in the minimum wage. The family benefit is updated according to inflation. The *Bolsa Escola* program, now *Bolsa Família*, is not regularly updated. Civil servant pensions are generally readjusted by the same index as to readjust civil servant wages (this

Table 1: Numbers of recipients/payers and cost/revenue of benefits/taxes in 2003: BRAHMS simulations compared with external statistics

	Number of taxpayers or recipients (in thousands)			Overall revenue/expenditure (in billions of reais)		
	External statistics (A)	BRAHMS estimation (B)	Ratio (B)/(A)	External statistics (A)	BRAHMS estimation (B)	Ratio (B)/(A)
Contributory benefits (incl. pensions)	22,149	21,58	97%	172.0	162.1	94%
Unemployment benefit	4,903	3,217	66%	6.5	4.7	72%
Family benefit	5,074	6,003	118%	1.1	1.6	154%
Bolsa escola	5,056	4,449	88%	1.4	1.2	84%
Social contributions (workers)	34,95	34,057	97%	30.3	29.4	97%
Income tax	6.000	7.215	120%	25,5	26,8	105%

Sources: OECD (2005), Ministério da Economia (2005), Ministério do Seguro Social (2005), and authors' own elaboration using BRAHMS, version 2003b.

is thus static in nature as it does not attempt to capture any behavioural adjustments that tax units may consider in response to changing tax burdens. This should be kept in mind when interpreting results particularly when looking at the cumulative effects of inflation over longer periods of time.[16]

4.3. Measures of inequality, redistribution and progressivity

To measure the effects of inflation on the distributional properties of the tax system, we use a set of common inequality indicators and compare them[17] between a "before inflation" and "after inflation" scenario. The inequality measures used are members of the so-called single parameter Gini (or S-Gini) family (Donaldson and Weymark, 1980, Yitzhaki, 1983). By choosing the value of an inequality aversion parameter v, the S-Gini (SG) allows different weights w to be put on the contribution of lower versus higher income groups to total inequality:[18]

$$SG(v) = \int_0^1 w(p - L(p))dp \qquad (1)$$

where

$$w = v(v-1)(1-p)^{v-2}, \quad v > 1 \qquad (2)$$

p is the rank of individuals in a population with individual observations ordered in ascending order of the variable (here income) whose inequality is to be measured and $L(p)$ is the Lorenz curve, *i.e.*, the share of total income earned by the poorest $p.100\%$. For $v = 2$, we have $w = 2$ and $SG(v)$ is the standard Gini coefficient of inequality where departures from equality $(p - L(p))$ are weighted equally for all p, while $v > 2 (< 2)$ gives more weight to smaller (larger) p.

index depends on negotiations between unions and the government, differing by union category). Private employee pensions, other than the minimum pension, are readjusted by inflation.

[16] However, in subsection 6.3 below, we discuss some of the likely behavioural effects of inflation.

[17] The analysis does not, therefore, consider the inter-temporal redistribution mechanisms built into social insurance schemes.

[18] See, e.g., Duclos and Araar (2006). A stimulating discussion of alternative interpretations of Gini coefficients is provided by Yitzhaki (1998).

Choosing an appropriate v, one can rank different distributions (e.g. before- and after-tax incomes) in terms of inequality or, alternatively, find the inequality aversion parameter v where rankings change. For empirical applications, it is therefore desirable to find intuitive interpretations of different v values. In principle, and as demonstrated by Blackorby and Donaldson (1978), relative inequality indices can be linked to a particular social evaluation function. For the S-Gini, a simple method for determining useful ranges of v is presented by Duclos (2000). Consider Okun (1975) "leaking bucket" experiment where a hypothetical transfer from a richer person to a poorer person involves some efficiency loss in the sense that the gain enjoyed by the recipient is less than the loss suffered by the donor. Linking v to this efficiency loss, it is possible to derive, for a given v, the implied fraction of the transfer that can be "lost" in the process while still making the transfer socially desirable. Choosing these amounts of tolerable wastage is perhaps more feasible or, at least, more intuitively appealing than directly deciding on an appropriate value of v. For rank-preserving transfers from a person with rank $p_1 = 0.67$ to a person with rank $p_2 = 0.33$ it turns out that with $v = 2$, the implied tolerated wastage amounts to 50% of the transferred amount. With $v = 1.5$ the amount would be only 29% and with $v = 3$ a rather high 75% so that a transfer would still be judged desirable if only a fourth of the amount paid by p_1 reaches the recipient p_2.[19] In the analysis that follows, we will present results for these three values of v.

The difference between the S-Gini index of inequality of pre-tax income SG_g and the S-Gini concentration index of net income CI_n is a measure of vertical redistribution. It indicates to which extent net incomes are more equally distributed than gross incomes and, for $v = 2$, corresponds to the well-known Reynolds-Smolensky redistribution index RS (Reynolds and Smolensky, 1977)

$$RS = SG_g 2 - CI_n(2) = 2\left(\int_0^1 p - L_g(p)d_p - \int_0^1 p - C_n(p)dp\right) \tag{3}$$

where $L_g(p)$ and $C_n(p)$ are, respectively, the Lorenz and concentration curves of before- and after-tax income. If the tax function incorporates characteristics other than income, then income units may have a different order of incomes before and after the operation of the tax system. For example in Brazil the income tax allowance for pensioners aged 65 or more will cause these pensioners, after the operation of the tax, to shift up the distribution relative to younger individuals with the same pre-tax income. If non-income characteristics are judged irrelevant, re-ranking can be regarded as an indication of horizontal inequity and thus reduces the equalising effect of the tax. In this case the redistributive effect RE of a tax is better measured as the difference between the pre- and post tax S-Gini indices of inequality, which captures the effect of re-ranking, expressed by the term d, on vertical redistribution:

$$RE = SG_g(2) - SG_n(2) = RS - d \tag{4}$$

The inequality reducing properties of a tax depend on the inequality of the distribution of tax burdens as well as their size. Formally, it can be shown that

$$RE = k\frac{r}{1-r} - d \tag{5}$$

where

$$r = \frac{(\mu_g - \mu_n)}{(\mu_g)} \tag{6}$$

[19] Given v, tolerable efficiency losses increase with the rank difference of the two individuals. For $p_1 = 0.8$ and $p_2 = 0.2$, for instance, the tolerable losses for $v = 1.5$, $v = 2$ and $v = 3$ amount to 50%, 75% and 94%.

$$k = 2\int_{0}^{1} p - C_t(p)dp - SG_g(2) \tag{7}$$

$$d = SG_n(2) - 2\int_{0}^{1} p - C_n(p)dp \tag{8}$$

and r is the size of the tax instrument expressed as the relative difference between mean gross and net incomes μ_g and μ_n, k is the Kakwani progressivity index (Kakwani, 1977), and d is the above-mentioned re-ranking term measuring by how much vertical redistribution is reduced as a result of differences in the ordering of gross and net incomes (Atkinson, 1980, Plotnick, 1981).[20] $C_t(p)$ and $C_n(p)$ are, respectively, the cumulative proportions of total tax burdens and net incomes at point p where individuals are ordered in terms of gross incomes. Since the decomposition works analogously for $w \neq 2$, we can derive measures of redistribution (RE) and progressivity (k) using different inequality aversion parameters v.

5. THE BRAZILIAN INCOME TAX

Although usually at the centre of the tax policy debate in Brazil, the share of the personal income tax on the overall tax revenue is smaller than in other countries. Table 2 shows that despite a similar total tax burden, as a proportion of GDP, the revenue derived from personal income taxation in Brazil is much lower than in the OECD average.

Table 2: Taxation in Brazil and in the OECD: 2003

	Total tax receipts *as percentage of GDP*	Tax structure *as percentage of total tax receipts*				
		Personal income tax	Corporate income tax	Social security contributions	Taxes on goods and services	Other taxes
Brazil	34.9	9.2	9.2	18.5	35.5	27.6
OECD average	36.3	24.9	9.3	23.3	32.1	10.4

Sources: Ministério da Economia (2005), OECD (2005) and OECD (2006).

Tax-benefit microsimulation allows us to go beyond aggregates and learn more about how the income tax is distributed. Table 3 reports the distribution of simulated income tax liabilities as a proportion of total income tax revenue and as a proportion of household disposable income. These figures relate to the simulation of the 2003 tax-benefit rules on 2003 data from the PNAD. Throughout the paper this simulation is taken as a "baseline". According to the simulation, the average income tax burden is 3.7 percent of the total household disposable income. Interestingly, and reflecting the high income inequality and relatively generous income tax exemption limit, only in the top decile the tax burden is higher than the average. The distribution of income tax liabilities in Brazil is very progressive. About 95% of the income tax revenue is paid by the richest 10 percent. The vast majority of the population is exempted.

The inequality reducing effect of the income tax in Brazil is limited. The S-Gini index after income tax is just slightly lower than before it. Table 4 shows that such low redistribution is driven by the

[20] Aronson et al. (1994) show that, since the unequal taxation of equal tax bases also reduces the equalising properties of a tax, another term capturing classical horizontal inequity can further broaden the scope of a decomposition exercise although, in empirical analyses, this involves a rather arbitrary decision about the interval within which tax bases are to be considered "equal". An empirical study along these lines has been undertaken by Wagstaff et al. (1999).

Table 3: Distribution of income tax by deciles: Brazil 2003

Deciles	% HDI	% income tax revenue
1	0.0%	0.0%
2	0.0%	0.0%
3	0.0%	0.0%
4	0.0%	0.0%
5	0.0%	0.0%
6	0.0%	0.0%
7	0.0%	0.0%
8	0.2%	0.6%
9	1.0%	4.5%
10	8.0%	94.8%
Total	3.7%	100.0%

Note: Deciles are computed for individuals ranked according to household disposable income (HDI) equivalised by the "modified OECD" equivalence scale.

HDI are calculated as the sum of all income sources of all household members net of income tax and social insurance contributions.

Source: Authors' own elaboration using BRAHMS, version 2003b.

small size of the income tax (r), despite high progressivity (k). These findings are qualitatively similar for different values of the inequality aversion parameter v. However, progressivity and redistribution are lower for larger values of v (i.e., a larger weight on the bottom income groups), as income tax only affects the top of the income distribution so that little redistribution is achieved at the bottom.

Table 4: Income inequality, redistribution and progressivity: Brazil 2003

	$v = 1.5$	$v = 2.0$	$v = 3.0$
S-Gini			
Income before income tax	0.3870	0.5380	0.6690
Income after income tax	0.3729	0.5241	0.6580
Redistribution $[RE = k * r/((1 - r) - d)]$	0.0142	0.0140	0.0110
Progressivity $[k]$	0.4189	0.4118	0.3256
Size of instrument [r]	0.0328	0.0328	0.0328
Re-ranking $[d]$	0.0001	0.0001	0.0000

Note: Income before income tax is calculated as the sum of all income sources of all household members, net of social insurance contributions but not of income tax, equivalised by the "modified OECD" scale. Income after income tax is the equivalised HDI (see note in Table 3). For details on indices and on inequality aversion parameter v, see subsection 4.3.

Source: Authors' own elaboration using BRAHMS, version 2003b.

Such results would change if monetary parameters of the income tax function are not adjusted for inflation. If incomes increase in line with prices, nominal income increases would move taxable income further up in the tax function. Figure 1 shows the rates of the 2003 tax schedule and a kernel density of incomes subject to IT within the [R$ 0, R$5000] interval. Although most people have incomes that are well below the income tax exemption limit and are unlikely to be affected by the lack of indexation unless inflation is exceptionally high or monetary parameters are not revised for a long period of time, there is a significant group of individuals just below the exemption limit that would be potentially affected by the lack of inflation adjustment. Nevertheless, differently from the evidence in other countries (Saez, 1999, Immervoll, 2005), no particular "bunching" is observed.

6. INCOME TAX AND INFLATION

6.1. Income tax responsiveness to inflation

How responsive is the Brazilian income tax to inflation? In particular, how the tax burden, number of taxpayers, progressivity and redistribution would be affected if no inflation adjustment was carried out? Here, we address those questions by simulating changes to the 2003 (baseline) scenario. In practice, the simulations consist on increasing all monetary inputs to the income tax calculation (e.g., market income, benefits, expenditures and social contributions) by synthetic inflation rates, while keeping the 2003 income tax rules constant. The differences between the new results and those from the baseline simulation are due to the lack of inflation adjustment in the income tax.

Table 5 presents the size, progressivity and redistributive effect of the income tax for a set of synthetic inflation rates (5, 10, 15, 20 and 25 percent) assuming no inflation adjustment. These results reveal that income tax revenue is quite responsive to inflation. If no adjustment is carried out, 10 percent inflation would increase the revenue, in real terms with respect to 2003, by 9.7 percent and the tax burden from 3.28 to 3.6 percent. The number of taxpayers is even more responsive to fiscal drag, 10 percent inflation would increase it by 11.7 percent. If no adjustment was applied on the income tax after a 20 percent increase in prices the number of taxpayers would rise by almost a third.

Table 5: Income tax size, progressivity and redistribution: no adjustment to synthetic inflation rates

Inflation (2003)	Revenue %(2003)	Tax Payers		$v = 1.5$		$v = 2$		$v = 3$	
			r	k	RE	k	RE	k	RE
	100.0%	100.0%	3.28%	0.4189	0.0142	0.4118	0.0140	0.3256	0.0110
5.0%	105.0%	105.5%	3.45%	0.4133	0.0148	0.4089	0.0146	0.3250	0.0116
10.0%	109.7%	111.7%	3.60%	0.4080	0.0153	0.4060	0.0152	0.3243	0.0121
15.0%	114.5%	122.5%	3.76%	0.4026	0.0158	0.4029	0.0158	0.3235	0.0127
20.0%	119.1%	132.2%	3.92%	0.3974	0.0162	0.3999	0.0163	0.3227	0.0132
25.0%	123.8%	138.0%	4.08%	0.3922	0.0167	0.3969	0.0169	0.3218	0.0137

Note: Indices computed through the comparison of income "before" and "after" income tax. r is the size of the tax, k is the Kakwani progressivity index, RE is the redistributive effect. For details on indices and on inequality aversion parameter v, see subsection 4.3.

Source: Authors' own elaboration using BRAHMS, version 2003b.

The simulations with BRAHMS also show that failing to adjust for inflation would reduce the income tax progressivity for all values of the inequality aversion parameter (v). The progressivity fall increases with inflation. Using $v = 2$, an inflation rate of 5 percent would reduce progressivity by 0.7 percent, while by 1.4 percent with a 10 percent inflation. Interestingly, the extent of the progressivity reduction changes significantly with v. An inflation rate of 20 percent would reduce progressivity by 5.1, 2.9 and 0.9 percent with v equal to 1.5, 2 and 3, respectively. As fiscal drag widens the tax base, the income tax affects further below in the income distribution and reduces the tax share at top (see Table 6), thus reducing progressivity at the top. In fact, after 15 percent inflation progressivity would be higher for $v = 2$ compared to $v = 1.5$.

Table 6: Proportion of income tax by deciles: no adjustment to synthetic inflation rates

Deciles	2003	Inflation				
		5%	10%	15%	20%	25%
1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	0.0%	0.1%	0.1%	0.1%	0.2%	0.2%
8	0.6%	0.7%	0.9%	1.0%	1.2%	1.4%
9	4.5%	5.0%	5.4%	5.9%	6.3%	6.7%
10	94.8%	94.2%	93.6%	93.0%	92.3%	91.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Deciles are computed for individuals ranked according to household disposable income (HDI) equivalised by the "modified OECD" equivalence scale. HDI are calculated as the sum of all income sources of all household members net of income tax and social insurance contributions.

Source: Authors' own elaboration using BRAHMS, version 2003b.

On the other hand, redistribution (RE) would rise with fiscal drag. Thus, recalling equation (5), the reduction in progressivity (k) is more than compensated by the higher tax burden (r). The redistributive effect increases monotonically with the inflation rate. Using $v = 2, 10$ percent inflation would increase redistribution by 8.7 percent, while 20 percent inflation would increase it by 17 percent. With regard to the inequality aversion parameter v, in proportional terms, rises in redistribution are higher for larger values of v. For an inflation of 20 percent, the redistributive effect would rise by 14, 17 and 19 percent with v equal to 1.5, 2 and 3, respectively. Contrary to results presented in Table 4, redistribution is no longer monotonically lower for larger values of v. For an inflation larger than 15 percent, redistribution with $v = 2$ would be higher than with $v = 1.5$. Nevertheless, as the redistributive effect of the income tax is quite low, even after relatively high levels of inflation, income tax redistribution would still be rather low. If no adjustment was introduced after 25 percent inflation, the reduction on income inequality (measured by the standard Gini coefficient) would be from 0.5241 to 0.5212 and not statistically significant.[21]

6.2. Income tax, inflation and adjustment in the period 2003-2008

Since 1999 all major changes on the rules of the personal income tax have been eventual increases in monetary parameters.[22] Although such increases were discontinuous and not in line with the inflation in any particular year, they consisted on uniform increases of the monetary elements of the income tax (deductions, limits and thresholds) by a single factor. Thus, it is generally accepted that such increases

[21] Confidence intervals, calculated using bootstrap techniques, are available from authors on request.

[22] In 1999 the highest rate of personal income tax was raised from 25 to 27.5 percent. Interestingly, the tax schedule limits and other monetary parameters remained the same as in 1998 and 1997.

were partial and time-lagged inflation adjustments. This irregular indexation policy has been revised in recent years. It is clear from Table 7 that the uprating factors for 2005 and 2006 were considerably higher than inflation, probably aiming to compensate the lack of adjustment in previous years. A regular and transparent indexation approach has been introduced for the 2007-2010 period. Income tax monetary parameters are uprated by the inflation target set by the Central Bank.

Table 7: Income tax adjustment and inflation: 1997–2010

Year	Income tax schedule			Inflation
	Band 1 (reais)	Band 2 (reais)	Adjustment (%)	
1997	900	1,8	–	5.2
1998	900	1,8	0.0	1.7
1999	900	1,8	0.0	8.9
2000	900	1,8	0.0	6.0
2001	900	1,8	0.0	7.7
2002	1,058	2,115	17.5	12.5
2003	1,058	2,115	0.0	9.3
2004	1,058	2,115	0.0	7.6
2005	1,164	2,326	10.0	5.7
2006	1,257	2,512	8.0	3.1
2007	1,314	2,625	4.5	3.5*
2008	1,373	2,743	4.5	4.1*
2009	1,435	2,867	4.5	–
2010	1,499	2,996	4.5	–

Note: Inflation index: extended consumer price index (Índice Nacional de Preços ao Consumidor Amplo – IPCA).

* Central Bank IPCA forecast.

Source: Banco Central do Brasil (2007).

How recent inflation adjustment policies have affected the burden and distributional effect of the income tax in Brazil? What would have been the burden and distributional effect of the income tax if no inflation adjustment had been applied between 2003 and 2008? In order to answer those questions we run two sets of simulations: *actual inflation adjustment* and *no* adjustment. In both scenarios all monetary inputs to the income tax are increased in line with the inflation rates in Table 7. However, while in the former scenario all income tax monetary parameters are uprated in line with the adjustment factors in Table 7, in the later all income tax rules are held as in 2003. It should be borne in mind that the simulations of *actual inflation adjustment* in 2004-2008 do not take into account the real evolution of incomes and of other determinants of income tax (e.g., household composition or medical and education expenses), therefore the results cannot be interpreted as forecasts of the income tax on those years.

Table 8 presents the size, progressivity and redistributive effect of the income tax for 2003 and both scenarios in the period 2004-2008. The variation of the income tax revenue clearly reflects the different inflation adjustment policies implemented in the period. In 2004, the combination of relatively high inflation (7.6 percent) and lack of adjustment increase the income tax revenue, in real terms, by 7.4 percent and the tax burden to 3.53 percent. Likewise, the number of taxpayers is 8.3 percent higher than in the previous year. In 2005 and 2006 the adjustment is deliberately higher than inflation. As a result, in 2006 the tax revenue, tax burden and number of taxpayers are below the 2003 levels.

Those indicators fall further in 2007 and 2008 as inflation forecasts are lower than inflation targets for both years. Comparing 2008 and 2003 scenarios, the revenue (in real terms) falls by 2.6 percent, the tax burden to 3.19 percent and the number of taxpayers by 6 percent. In contrast, if no inflation adjustment was applied in the period, the revenue (in real terms) would rise by 25 percent, the tax burden to 4.12 percent and the number of taxpayers by 39 percent.

Table 8: Income tax size, progressivity and redistribution: actual inflation and adjustment

Year	Revenue % (2003)	Tax payers		$v = 1.5$		$v = 2$		$v = 3$	
			r	k	RE	k	RE	k	RE
2003	100.0%	100.0%	3.28%	0.4189	0.0142	0.4118	0.0140	0.3256	0.0110
Actual inflation adjustment									
2004	107.4%	108.3%	3.53%	0.4105	0.0150	0.4074	0.0149	0.3246	0.0119
2005	103.4%	104.5%	3.39%	0.4151	0.0146	0.4098	0.0144	0.3252	0.0114
2006	98.7%	95.0%	3.24%	0.4204	0.0141	0.4126	0.0138	0.3258	0.0109
2007	97.8%	94.4%	3.21%	0.4214	0.0140	0.4131	0.0137	0.3259	0.0108
2008	97.4%	94.0%	3.19%	0.4218	0.0139	0.4133	0.0136	0.3260	0.0108
No adjustment									
2004	107.4%	108.3%	3.53%	0.4105	0.0150	0.4074	0.0149	0.3246	0.0119
2005	113.3%	121.3%	3.72%	0.4040	0.0156	0.4037	0.0156	0.3237	0.0125
2006	116.6%	124.9%	3.84%	0.4002	0.0160	0.4016	0.0160	0.3231	0.0129
2007	120.4%	133.0%	3.96%	0.3959	0.0163	0.3991	0.0165	0.3224	0.0133
2008	125.0%	139.1%	4.12%	0.3908	0.0168	0.3960	0.0170	0.3216	0.0138

Notes: Indices computed through the comparison of income “before” and “after” income tax. r is the size of the tax, k is the Kakwani progressivity index, RE is the redistributive effect. For details on indices and on inequality aversion parameter v, see subsection 4.3.

Source: Authors’ own elaboration using BRAHMS, version 2003b.

Consistently with results presented above, progressivity falls/rises and redistribution rises/falls when the level of adjustment is lower/higher than inflation. Proportional changes in progressivity are larger for the inequality aversion parameter $v = 1.5$, while changes in redistribution are larger for $v = 3$. Nevertheless, in all cases the changes in progressivity and redistribution are very small. The largest progressivity and redistribution variations are in the year 2004, using $v = 2$ progressivity decreases by 1.1 percent and redistribution increases by 6.7 percent. As, over the whole (2003-2008) period, the adjustment is larger than inflation, progressivity is slightly larger and redistribution lower 2008 than in 2003. Thus, measured by the standard Gini coefficient ($v = 2$), income inequality rises from 0.5241 to 0.5244 (this difference is not statistically significant). If no inflation adjustment had been implemented over whole period, progressivity would have fallen to 0.3960 and redistribution would have increased to 0.0170 (using $v = 2$). In that case, the standard Gini coefficient would have fallen to 0.52108 (this difference is also not statistically significant).

6.3. The likely effects of inflation on tax payments under behavioural responses

As mentioned in subsection 4.2, this paper does not attempt to capture any behavioural adjustments that tax units may consider in response to changes in tax burdens. However, it may be useful to consider the likely directions in which labour supply responses might change our results, in particular with respect to the effects of inflation on income tax revenue.

In the standard model of labour supply, a progressive income tax influences individual choices through a change in the marginal wage as well as a change in lump sum income. This can be illustrated using a two-good diagram, following Auerbach (1985, p.85).[23] For example, consider the case of the Brazilian income tax, with an exemption limit and two marginal rates, t_1 e t_2. This leads to three after-tax wages: w_0 equal to pre-tax wage; $w_1 = w_0(1 - t_1)$ e $w_2 = w_0(1 - t_2)$. The individual's pre-tax and after-tax budget lines are represented in Figure 2. H_1 and H_2correspond to hours supplied at the intersection of the two tax brackets.

The important point to note is that the effect of this progressive tax on the behaviour of an individual whose preferred hours of work were previously between H_1 and $H_2$is equivalent to the effect of a proportional tax at rate t_1 plus lump sum income y_1. If the individual's preferred hours of work were previously above H_2 the effect of the tax is equivalent to the effect of a proportional tax at rate t_2 plus lump sum income y_2.[24]

By reducing the real value of deductions and the real width of the tax brackets, inflation decreases the lump sum incomes of all individuals above the exemption limit. As long as they remain on the same budget segment, this would induce more labour supply. However, there may be some 'bracket creep': some individuals initially below the exemption limit may be moved to the second budget segment, with a positive marginal rate t_1 and some people previously on the second budget segment may shift to the third tax bracket, with higher marginal rate t_2.

As can be seen from Figure 2, shifting to a higher tax bracket reduces marginal wage and increases lump sum income. The change in wage alone leads to offsetting 'income and substitution effects' (just as in the standard economic analysis of price changes), and the change in lump sum income generates a further 'income effect' which induces less labour supply. Thus, in the case of individuals which remain on the same tax bracket, including all those in the highest tax bracket, inflation will cause them to increase work effort and therefore pay more tax. But, if an individual is moved to a higher tax bracket, labour supply responses can go either way, depending on preferences. In the case of Brazil, we might expect a positive net effect of inflation on income tax revenue in the presence of labour supply responses, possibly higher than that estimated in this paper, since the bulk of the tax is collected from people in the highest tax bracket.[25]

It should be noted that in attempting to capture labour supply responses to tax changes, it is crucial to correctly associate individuals with differing wage and income responses to appropriate points on the tax schedule, since wage elasticities and effective marginal tax rates diverge substantially across individuals. As argued by Blundell (1996), it is difficult to believe that such task can be achieved without a micro-simulation (behavioural) model. On the other hand, there are channels through which inflation may alter the behavioural and distributional effects of taxation which can only be captured within a general equilibrium framework. For instance, it is well known that inflation tends to increase the real capital income tax burden in a nominally based tax system and thus reduces the real net return on savings. A number of articles have used general equilibrium growth models to analyse how this affects the real equilibrium and the growth path of the economy, as well as wealth distribution.[26]

7. CONCLUSIONS

Making use of a tax-benefit microsimulation model for Brazil to simulate different scenarios regarding the level of inflation and the adjustment of the income tax rules, we have assessed the potential revenue and distributive effects of inflation on the income tax.

[23] See also Hausmann (1985).

[24] Lump sum incomes y_1 and y_2 are also referred to as 'virtual incomes'.

[25] The analysis here ignores other behavioral responses, like shifting jobs to the informal sector.

[26] For example, Neudeck (1981) and Heer and Sussmuth (2007).

Our results show that the income tax revenue is quite elastic to fiscal drag. Income tax burden would increase if tax rules are not adjusted for inflation. Nevertheless, as the income tax burden in Brazil is quite low, it would remain rather low if inflation is moderate and the period without adjustment is not excessively long.

The influence of fiscal drag on the distributive properties of the income tax is considerable. Our simulations show that income tax progressivity would decrease if it is not adjusted for inflation. The reduction level would increase with inflation. As the income tax only affects the top of income distribution, progressivity changes would be significantly lower for measures that give larger weight to bottom income groups.

As to redistribution, inflation-induced reductions in progressivity are more than compensated by higher tax burdens. Redistribution increases with inflation if the income tax is left unadjusted. Yet again, as the redistributive effect of the income tax is quite low, even after relatively high levels of inflation, income tax redistribution would still be rather low. If no adjustment was introduced after 25 percent inflation, the reduction on income inequality (measured by the standard Gini coefficient) – from 0.5241 to 0.5212 – would not be statistically significant.

After a period of no or irregular adjustment, income tax has been considerably adjusted for inflation in recent years. In 2005 and 2006, inflation adjustment compensated the lack of adjustment in previous years. From 2007 to 2010, income tax monetary parameters are adjusted in line with the inflation target set by the Central Bank. As the rate of adjustment for 2003-2008 is larger than the expected inflation, the revenue (in real terms), tax burden and the number of taxpayers in 2008 are lower than in 2003. Progressivity is slightly higher, but not enough to compensate the lower tax burden as redistribution goes down.

Hence, our findings contradict the view that adjusting income tax for inflation would reduce the tax base and *progressivity*. Quite the opposite, our results show that the lack of adjustment reduces progressivity, although it increases the redistributive effect through a larger tax burden. On the other hand, we agree that the income tax base is small and that most alternative taxes (mainly indirect ones) are potentially less progressive (if not regressive) than the income tax. However, in our view, fiscal drag should not be used as an alternative to tax reform. First, because it only would significantly change the redistributive effect of the income tax if inflation is exceptionally high or no adjustment is carried out for a long period of time. Second, because the size of income tax base, revenue and redistributive effect should be determined by transparent and explicit policy objectives that are consistent over time rather than by circumstantial inflation rates.

Careful modelling of policy alternatives can contribute to the design of the income tax to reach policy objectives. This paper has illustrated the potential of tax-benefit microsimulation techniques in assessing the revenue and distributive effect of tax reforms and of policies under different scenarios (such as different levels of inflation and policy rule adjustment).

Of course, the reform of the income tax must take into account the size, structure and distribution of other taxes and benefits as well as their interaction with the income tax. Therefore, in order to enhance the scope of future tax-benefit reform analysis, it would be desirable to extend the number of policy measures that BRAHMS can account for, particularly indirect taxes. On-going work in OECD countries and availability of data from a recent household budget survey indicates that model extensions in these directions would in fact be feasible in Brazil. This would allow analysts to evaluate the budget and redistributive impact of comprehensive reforms.

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