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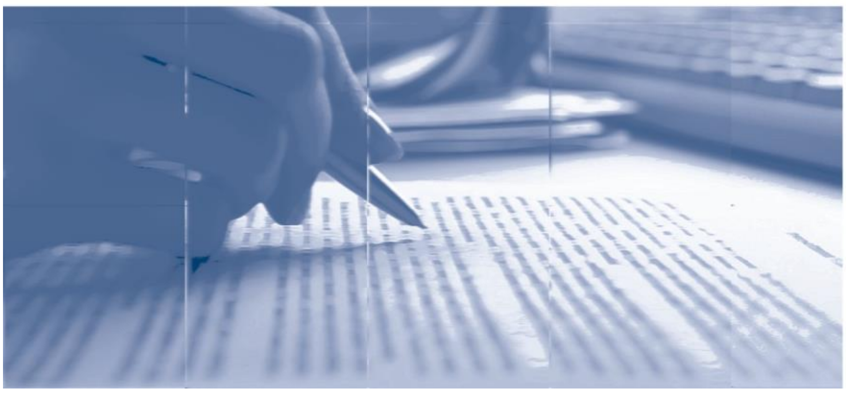

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Effective Tax Rates on Consumption and Factor Incomes: a quarterly frequency estimation for Brazil*

Cyntia Freitas Azevedo†

Angelo Marsiglia Fasolo‡

Abstract

This paper estimates time series of effective tax rates for consumption and factor incomes for Brazil, following the spirit of Mendoza et al (1994)[12]. The procedure to generate quarterly estimates of the tax base, using microdata from populational surveys, and the tax revenues seems to be appropriate, despite its simplicity, as the time series of the tax burden and the effective tax rates are in line with the historical Brazilian experience on fiscal policy. The estimated tax burden identifies a positive trend over time, despite the partial interruption after the international crisis in 2008. The paper also provides preliminary evidence on the properties of the computed effective tax rates and their relation with the business cycles.

Keywords: Fiscal policy; Effective tax rates; Consumption tax; Factor income taxes

JEL Classification: E62, F41

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1 Introduction

The main purpose of this study is to construct quarterly time series of the effective tax rates on consumption, labor and capital for Brazil. An appropriate measure of tax rates is central for the construction of macroeconomic models that aim at evaluating the impacts of fiscal policy. As pointed by Mendoza et al (1994)[12], *"these tax rates are necessary both to develop quantitative applications of the theory and to help transform the theory into a policy-making tool"*. However, calculating these rates, specially at a higher frequency, has proven to be a very challenging task. In Emerging Economies, where the quality and availability of information on tax collection and its tax base are usually questionable, the number of strong assumptions necessary to make inference about tax rates might prove the exercise useless.

In Brazil, particularly, there are two types of problems associated with the computation of average effective tax rates and its use as a policy-making tool. The first problem, associated with the computation of the tax base, is a result of the lack of timely updates in National Accounts necessary to keep the estimates of tax rates useful for policy exercises. The National Accounts in Brazil provide estimates of labor and capital income at annual frequency only and with very long delays. As of today, the last information available from the Brazilian Institute of Geography and Statistics (IBGE, in Portuguese) finishes in 2009. Thus, the construction of estimates of the effective tax rates at a frequency higher than annual demands additional hypotheses to replace the available information on capital and labor returns based on the National Accounts.

The second type of problem is related to information on fiscal policy in Brazil – more specifically, on information from subnational entities of the Federation. Data on revenues and expenses of the Federal Government are available at monthly frequency with very little delay. For municipalities, however, detailed information from official authorities is available at annual frequency only, mostly from a recent comprehensive dataset published by the National Treasury Secretariat ("Secretaria do Tesouro Nacional", in Portuguese) called FINBRA. Also, in terms of tax collection, an annual study published by the Secretariat of the Federal Revenue ("Secretaria da Receita Federal", in Portuguese) estimates the total tax burden over the Brazilian economy for the previous fiscal year. Building a real time estimate of effective tax rates in Brazil demands accessing information on tax revenues and contributions to civil servants' social security system from sources other than official National authorities responsible for conducting fiscal policy in the country.

This paper proposes solutions for these problems, trying to overcome the issues presented above using alternative sources of information and providing a detailed methodology to compute effective taxes in Brazil. In order to solve problems associated with information from subnational entities, we built a system capable of downloading, reading and compiling information from reports that each subnational government is required to submit bimonthly to a public access database run by a federal public bank (Caixa Econômica Federal) together with the National Treasury Secretariat[1]. Each report is submitted in a standard form, converted to PDF format when made available for public consultation. Thus, the computational system must be capable of: 1) downloading, for each unit of subnational government, the bimonthly reports in PDF format; 2) converting reports to a format in which other software is able to read the information; 3) compiling, with the support of other computational tools, a single, aggregate dataset of each variable for the use in our exercises. The idea of using such system to calculate tax revenues from states and municipalities is not new: Orair et al (2013)[15], in a parallel effort from the development of this paper, built a similar system to obtain monthly estimates of the total tax burden applied over the Brazilian economy. In this paper, we take a step further, collecting also information on government spending and civil servants' contributions to their social security system from the same set of reports. We also take a simpler approach in order to estimate gaps in the information from municipalities, combining data from FINBRA to fill the missing gaps.

To construct a quarterly series on labor and capital income, instead of relying on information from the National Accounts, we use microdata from three population surveys available at different frequencies. These surveys provide information on employment and average wages, from which we compute the aggregate labor compensation in the economy. The use of data from three different surveys required a detailed evaluation of the labor income distribution profile over time. This information is taken into account when building the time series of total labor income for the Brazilian economy.

In this paper, we provide annual values of effective taxes for Brazil, from 1999 until 2009, based on information from the National Treasury Secretariat, Secretariat of the Federal Revenue and the National Accounts. We also detail the methodology employed to build a quarterly dataset using the reports provided by subnational governments and population surveys. Under an additional set of assumptions, given the available amount of information collected, we were able to construct a quarterly dataset on tax revenues and the tax base from 1999 to 2014. The comparison of annual rates with the 4-quarter cumulative rates computed using the high-frequency dataset shows some discrepancies, most likely due to the quality of data provided by subnational governments. Gaps between annual data and the high-frequency dataset mostly affects the composition between capital

[1]Starting in 2015, the National Treasury Secretariat introduced a new system for collecting and organizing information on the public accounts. The new system (Siconfi) summarizes data on regional governments collected from both SISTN and annual data from FINBRA. It is available in https://siconfi.tesouro.gov.br/siconfi/index.jsf

and labor taxes, despite preserving the dynamics over time of both effective tax rates. Given the final dataset on average effective tax rates, we also provide an initial analysis on the sources of fluctuations in those rates. Changes in average effective tax rates are associated with both changes in tax policy and changes in the overall state of the economy.

The paper is organized as follows. The next section discusses the literature on computing effective tax rates, with special focus on previous efforts documented for the Brazilian economy. Section 3 outlines the methodology of computing average effective tax rates for Brazil, following closely the work of Mendoza et al (1994)[12] and Lledó (2005)[10], while also presenting the additional hypotheses necessary to move from the annual to the quarterly estimates. Sections 4 and 5 apply the described methodology to compute effective rates at annual and quarterly frequencies, respectively, presenting all the necessary adjustments due to the data collected – especially in terms of high-frequency database on tax and contributions revenues and on the tax base. An empirical analysis of the quarterly time series of effective tax rates is presented in section 6. Section 7 concludes.

2 Related Literature

The main reference on the computation of effective tax rates is the work of Mendoza et al (1994)[12]. Their approach allows to estimate the effective tax rates on consumption and factor incomes consistent with the tax distortions faced by a representative agent in a general equilibrium framework. One of the advantages of their method is that it does not require a rigorous treatment of the tax legislation. It is a simple method that requires only data from the National Accounts and tax revenues statistics, allowing cross-country comparisons. They point out to three objectives achieved by their approach: (*i*) it takes into account the net effect of existing rules regarding credits, exemptions and deductions; (*ii*) it separates taxes on labor income from taxes on capital income; and, (*iii*) it incorporates the effects of taxes not filed with individual income tax revenues, such as social security contributions and property taxes, on factor income taxation. Given the authors objective, it is an appropriate methodology to compute average tax rates, capturing the effects of changes in tax deductions, tax credits and a general characterization of feedback effects on taxes from economic agents. It does not, however, measure important movements in taxes with significant macroeconomic impacts, like changes in marginal tax rates, as highlighted in Carey and Rabesona (2002)[3]. Average effective tax rates might also be sensitive to other issues, like tax planning and the international taxation of capital flows.

The work of Mendoza et al (1994)[12] and Carey and Rabesona (2002)[3] is focused on the use of data compiled by OECD, usually available for large time spans, with detailed definitions and good quality control of information across countries, allowing reasonably appropriate cross-country comparisons. As mentioned in the introduction, datasets from Emerging Economies usually show problems that might compromise the estimates of such tax rates[2]. For Brazil, specifically, there is a growing literature on the evaluation of the impacts of fiscal policies and tax reforms. In general, these studies apply some measure of average effective tax rates in order to calibrate models or to perform econometric analysis. Due to the problems listed here and in the introduction – namely, the lack of accurate and updated data on fiscal variables for long periods of time, at higher frequency and with little delay; and the lack of details and information with regular updates from the National Accounts with respect to the returns of labor and capital for the Brazilian economy –, the few studies that computed effective tax rates for Brazil used annual data only.

One example of a study using estimates of effective tax rates for Brazil is provided by Araújo and Ferreira (1999)[1], who evaluate the allocative effects and welfare impacts of a tax reform. The authors use a neoclassical model calibrated with information of tax rates based on total tax revenues of 1995. Cavalcanti and Silva (2010)[5] use an overlapping generations (OLG) model to study the impact of tax reforms on GDP, capital accumulation and welfare. Simulations estimated the effects of capital and labor tax exemption measures, compensated by increases in income tax. They compute tax rates based on data from the National Accounts for the year of 2004.

One of the first attempts to apply the methodology from Mendoza et al (1994)[12] for Brazil was made by Araújo Neto and Sousa (2001)[2] to study the comovements between macroeconomic aggregates and average effective tax rates. They make a good correspondence between the standard OECD coding for tax revenues used by Mendoza et al (1994)[12] and the different sources of tax revenues in Brazil. The authors were able to compute annual average tax rates on consumption, labor and capital using data on tax revenues and the National Accounts from 1975 to 1999. They faced, however, problems to construct the dataset due to missing data, despite still being able to provide a relatively long time series.

Lledó (2005)[10] constructs a dynamic general equilibrium model to analyze the macroeconomic and redistributive effects of replacing turnover and financial taxes in Brazil by a consumption tax. He uses an OLG model calibrated with data for 2002, computing effective tax rates based on the framework of Mendoza et al (1994)[12], modified to incorporate details of the Brazilian economy and features of the OLG model. Ferreira and Pereira (2010)[7] follow the procedure presented by Lledó (2005)[10] to calibrate a simple RBC model to analyze the impact of a tax reform in the Brazilian economy. They assume,

[2]Volkerink, Sturm and de Haan (2002)[18] note that even the use of OECD data might be flawed. They compute the effective tax rates for a group of OECD countries using data from local, national sources and find significant discrepancies in results compared to Mendoza et al (1994)[12].

from the first order conditions of the model, that the tax base is proportional to changes in aggregate output, as the labor and capital shares are determined by a single parameter of the production function.

While the previous two papers calibrate models using information from a single year, Pereira (2009)[16] computes effective tax rates on consumption, individual income, labor income and capital income from 2001 to 2005. The author follows the methodology presented by Mendoza et al (1994)[12], adapted to specific features of the Brazilian economy, in order to build the dataset used to calibrate a model to analyze the impact of fiscal policies on business cycles.

Finally, other alternatives to compute effective tax rates are based on a combination of input-output tables and microdata, using disaggregated information to analyze the inequality of the tax burden over the economy. While not avoiding the hypothesis of a full pass-through of taxes to consumers, studies based on disaggregated data provide useful information on marginal tax rates. For Brazil, Siqueira et al (2001)[17] use information from input-output tables of 1995 to compute effective tax rates on consumption for Brazil, disaggregating information on economic sectors and tax incidence over demand components for Brazil. More recently, Nogueira et al (2013)[13] use microdata from two population surveys to simulate a model, trying to estimate the tax burden inequality over labor income for the Brazilian economy in 2009. The model simulated in Nogueira et al (2013)[13] receives as an input not only survey data, but also information from Brazilian legislation on tax rates. The idea of using information from the legislation as an input for modelling purposes was adopted in Carvalho and Valli (2011)[4] to calibrate a DSGE model for the Brazilian economy.

Previously mentioned literature worked only with annual data on tax revenues and the National Accounts. To the best of our knowledge, the first attempt to construct a high-frequency database on tax revenues for Brazil was made by Orair et al (2013)[15]. The authors estimate the Brazilian tax burden at monthly frequency from 2002 until 2012. Their estimation of subnational government information on taxes is very precise, mostly by their effort on building a complex state-space model to estimate high-frequency time series based on low-frequency information available. The compilation of a dataset of tax revenues of subnational entities is analogous to what is done in this paper, with the development of a system capable of reading several reports from PDF files. As said before, the main focus of Orair et al (2013)[15] is on the evolution of the tax burden; our paper, on the other hand, combines information on tax revenues with a high-frequency inference on the tax base to compute effective tax rates.

3 Computing Effective Tax Rates

This section details the methodology employed to compute the average effective tax rates for Brazil, both at the annual and quarterly frequencies. We closely follow the presentation in Lledó (2005)[10], who adapted the basic methodology of Mendoza et al (1994)[12] to Brazil, to discuss the computation of effective rates for the country. The section starts providing some context on the way effective tax rates are computed here, with possible applications in a general equilibrium framework. It follows with details on the definitions of tax rates on consumption, labor and capital income, followed by a presentation on the adjustments performed when working with quarterly data, with the necessary adaptations to the specificities of the Brazilian tax system. A complete description of datasets, along with a discussion on the appropriate separation of taxes under each class, are presented in the next section.

3.1 Effective Tax Rates in General Equilibrium

This subsection relates the average effective tax rates computed in this paper with a very broad framework of dynamic general equilibrium models. The objective is to provide context on the incidence of taxes in theoretical models, while also outlining a few difficulties when dealing with Brazilian data. Despite its relevance, the general equilibrium framework presented here does not include any form of heterogeneity on households or firms. A few topics related to agents' heterogeneity, like the effects of labor income distribution on effective tax rates on labor, are discussed on section 6.

A general description of the budget constraint of a representative household includes the total spending on consumption goods (c_t), investment on capital goods (i_t) and government debt holdings (b_t), on the expenses side. On the revenues side, it includes interest received on previously held government debt ($r_t b_{t-1}$), returns on production factors ($w_t h_t$ and $r_t^k k_t$ as the returns on labor supply and capital rental, respectively) and firms' profits (ϕ_t) (all variables in nominal terms). Spending on consumption goods includes the expenditure on taxes levied exclusively on those goods and paid by households, $\tau_{c,h}$. Gross capital and labor incomes are net of taxes paid by households – $\tau_{l,h}$ and $\tau_{k,h}$, respectively. In order to account for taxes levied on general income, that cannot be split in terms of capital and labor, the budget constraint also includes an additional tax rate (τ_y), equally charging the household's returns on the production factors[3].

$$(1+\tau_{c,h})\,c_t + i_t + b_t = r_t b_{t-1} + (1-\tau_{l,h}-\tau_y)\,w_t h_t + (1-\tau_{k,h}-\tau_y)\,r_t^k k_t + \Phi_t \qquad (1)$$

[3]If the model does not allow for taxes on aggregate income, one can use $(\tau_{l,h}+\tau_y)$ as the effective tax rate on labor and $(\tau_{k,h}+\tau_y)$ as the effective tax rate on capital levied on households.

On the firms' side, profits are generated by the revenue of selling output, minus payments to labor and capital used during the production process. Output (y_t) is consumed by households (c_t), and the government (g_t) or used as investment good (i_t). Similar to the equation describing the households' budget constraint, there are taxes levied on the output sold as a consumption good[4], $\tau_{c,f}$, on total payroll, $\tau_{l,f}$, and rented capital, $\tau_{k,f}$ that are paid by the firm.

$$\Phi_t = (1 - \tau_{c,f})(c_t + g_t) + i_t - (1 + \tau_{l,f}) w_t h_t - (1 + \tau_{k,f}) r_t^k k_t \tag{2}$$

$$y_t = c_t + g_t + i_t = w_t h_t + r_t^k k_t \tag{3}$$

In the analytical example described above, revenues from the general income tax rate are given by[5]:

$$T_y = \tau_y \left(w_t h_t + r_t^k k_t \right)$$

Similarly, tax revenues on consumption, labor and capital income are computed using the total revenues collected from households and firms:

$$T_c = (\tau_{c,h} + \tau_{c,f})(c_t + g_t) \qquad T_l = (\tau_{l,h} + \tau_{l,f}) w_t h_t \qquad T_k = (\tau_{k,h} + \tau_{k,f}) r_t^k k_t$$

Once information on tax revenues is available, effective tax rates on consumption (τ_c), income (τ_y), labor income (τ_l) and capital income (τ_k) are computed using the definition of their respective tax bases:

$$\tau_c = \frac{T_c}{c_t + g_t} \qquad \tau_y = \frac{T_y}{w_t h_t + r_t^k k_t} \qquad \tau_l = \frac{T_l}{w_t h_t} \qquad \tau_k = \frac{T_k}{r_t^k k_t}$$

The equations above highlight two important features of computing average effective tax rates. First, calculating aggregate tax rates does not depend if taxes are levied on households or firms, since, in general equilibrium, taxes levied on firms are also affecting households' decisions, either through the pricing and production decisions of the firms, or through the profits transferred to families. Only two pieces of information are necessary to calculate such tax rates – tax revenues and the tax base – and this information does not depend on the agent of the economy charged with the tax.

Second, disaggregated measures of effective tax rates are conditioned on the information set on tax revenues. For Brazil, as sections 4 and 5 show, information on labor income taxes allows a reasonable approximation of effective rates levied on firms and households, $\tau_{l,h}$ and $\tau_{l,f}$. Unfortunately, the same disaggregation is not possible with respect to taxes

[4]In this example, without loss of generality, assume that goods demanded for investment are not taxed by the government.

[5]For the sake of notation, define T_x as the total revenue from taxes over aggregate x. Define also τ_x as the effective tax rate over aggregate x.

on consumption and capital income.

Ideally, if data on tax revenues and the tax base were readily available, it would be simple to compute average effective rates for a simple economy like the one described above. The main challenge here is to build both types of datasets, specially at higher frequency, where detailed information is scarce. The adjustments applied to Brazilian data in order to compute the effective tax rates both at annual and quarterly frequencies are discussed in the rest of the section.

3.2 Effective Tax Rate on Consumption

The effective average tax rate on sales of consumption goods is given by:

$$\tau_c = \frac{T_c}{C + G - GW - T_c} \tag{4}$$

where T_c represents the total revenue from taxes on consumption of goods and services and excise taxes. C and G are the National Accounts data on private and government consumption, respectively. GW is the compensation of government employees. In order to obtain the pre-tax value of consumption, which is the definition of the tax base, revenues on consumption tax are discounted in the denominator, since the Brazilian National Accounts measure consumption expenditures at post-tax prices.

For the sake of comparison, Pereira (2009)[16] does not include government consumption on the tax base. Here, as in Mendoza et al (1994)[12], government consumption is included, net of the compensation of government employees ($G - GW$), as the tax revenues statistics include taxes paid by the government in the purchase of goods and nonfactor services.

3.3 Effective Tax Rates on General Income

The major problem associated with the definition of tax rates on labor and capital income is the identification of the tax burden over household's labor and capital income. The problem, pointed out by Mendoza et al (1994)[12] and also observed in Brazilian data, is that information sources usually do not provide a clear breakdown of the tax incidence over individual income. In order to overcome this problem, Mendoza et al (1994)[12] assume that all sources of household's income from labor supply and capital rental are taxed at the same rate when directly taxed.

In the framework of Mendoza et al (1994)[12], the tax rate over individual income is computed as a first step to obtain tax rates over labor and capital incomes. In the second step, an exogenous parameter defining a constant labor share of income is used to split tax revenues and tax base for each production factor. Lledó (2005)[10] points out that this imputation assumes a symmetric tax treatment between labor and capital income. As in Lledó (2005)[10], equation 1 allows an effective tax rate on household's general income to coexist with separate taxes on capital and labor. The effective tax rate on total individual income is then given by:

$$\tau_y = \frac{T_y}{W + RMB + EOB} \tag{5}$$

where T_y is the total revenue collected by the individual income tax rate. The denominator is defined as the net domestic income, which is the sum of wages and salaries (W), gross mixed income[6] (RMB) and the gross operating surplus (EOB), obtained from the National Accounts. The sum $W + RMB + EOB$ corresponds to the income households receive from labor supply and capital rental, $w_t h_t + r_t^k k_t$.

3.4 Effective Tax Rates on Labor and Capital

Once income taxes are properly classified based on its incidence, the final step to compute effective tax rates is to use information from the National Accounts to split household's income from labor supply ($w_t h_t$) and capital rental ($r_t^k k_t$). Mendoza et al (1994)[12] define wages and salaries, W, as labor income, and the sum of RMB and EOB as capital income. On the other hand, Lledó (2005)[10] considers the gross mixed income, RMB, as part of labor compensation, arguing that most of this income is generated from small labor-intensive unincorporated enterprises (physicians, attorneys, etc.).

Pereira (2009)[16] assumes that income distribution follows the shares of capital and labor in a Cobb-Douglas production function (capital share defined here as α). These shares are also used to distribute the pre-tax income of the economy, setting the tax base for labor, $(1-\alpha)(W + RMB + EOB)$, and capital taxes, $\alpha(W + RMB + EOB)$. This method has the advantage of avoiding additional assumptions over income distribution. However, the usual procedure to calibrate α sets restrictions for the source of gross mixed income, RMB. At the same time, as said before, setting a single value for α imposes that the share of labor and capital income are constant over time.

Following Lledó (2005)[10] and Considera and Pessoa (2011)[6], assume that labor remuneration, $w_t h_t$, is equal to wages and salaries plus gross mixed income, $W + RMB$, while capital income, $r_t^k k_t$, is given by EOB. Once the tax base is properly defined, the tax rate on labor income is given by:

$$\tau_l = \frac{T_l}{W + RMB} \tag{6}$$

where T_l is the total revenue of taxes over households' labor income and social security

[6] Gross mixed income is the compensation received by the owners of unincorporated enterprises (self-employed), which can not be separately identified between capital and labor.

contributions. In an analogous way, the tax rate on capital income is given by:

$$\tau_k = \frac{T_k}{EOB} \tag{7}$$

where T_k is the total revenue obtained by taxes over capital income, especially income from corporations and taxes on property and financial transactions.

3.5 Effective Tax Rates at Quarterly Frequency

Computing effective tax rates at quarterly frequency is not straightforward from the framework outlined above. While the high-frequency database on tax revenues constructed in section 5.1 contains the same information of the annual database (T_c, T_y, T_l and T_k), additional steps are necessary to compute quarterly time series of the tax base used in equations 5, 6 and 7. The tax rate on consumption, τ_c, is still given by equation 4, as every component of the tax base is also available at quarterly frequency.

In Brazil, the National Accounts provides data on total factor income only at annual frequency. In order to overcome this problem, notice first that, using the Income Approach of National Accounts, the gross domestic income of the economy (Y), net of taxes paid over production, is given by the total income received by residents from labor ($w_t h_t$) and capital ($r_t^k k_t$):

$$Y - Net\ Taxes = w_t h_t + r_t^k k_t = W + RMB + EOB \tag{8}$$

In order to build the denominator in equation 5, the left-hand side of equation 8 is approximated by the difference between gross domestic product (GDP) and a set of taxes classified in Orair at al (2013)[15] as part in the National Accounts of total taxes on production[7], available at quarterly frequency. In Pereira (2009)[16], this denominator is defined as the difference between GDP and total taxes on consumption, $Y - T_c$. While a significant share of the so-called "taxes on production" is classified as taxes on consumption, the procedure in Pereira (2009)[16] ignores that some taxes over labor income are also significant in the actual composition of "net taxes" in the National Accounts[8]. Under this assumption, the quarterly effective tax rate on individual income is given by:

$$\tau_y = \frac{T_y}{Y - Net\ Taxes} \tag{9}$$

[7]The lack of quarterly information in the National Accounts forces a decision to ignore the value of the subsidies to production. We recognize that this procedure might not be appropriate, as subsidies represent, on average, 1.8% of GDP over the period analyzed.

[8]The actual composition of our approximation of "net taxes" and the differences in classification of taxes with respect to other papers in the literature are presented in section 4.

The total pre-tax labor income, $w_t h_t$, is defined in the National Accounts as the sum of the gross wage income received by the labor force, WI, and the share of social security contributions charged on firms' payroll, FC :

$$w_t h_t \equiv WI + FC \tag{10}$$

Section 5.2.2 describes the procedure based on population surveys used to construct a quarterly time series for WI. It also shows the main sources of information to build a dataset for FC, using only the contribution paid by employers to the social security system. The quarterly effective labor income tax rate is, then, defined by:

$$\tau_l = \frac{T_l}{WI + FC} \tag{11}$$

Capital income is calculated as a by-product of the estimate of pre-tax labor income, according to equation 8:

$$r_t^k k_t \equiv Y - Net\ Taxes - WI - FC \tag{12}$$

implying the effective tax rate over capital income at quarterly frequency to be given by:

$$\tau_k = \frac{T_k}{Y - Net\ Taxes - WI - FC} \tag{13}$$

4 Tax Rates at Annual Frequency

This section computes effective tax rates at annual frequency using a dataset on tax revenues available from reports of the Secretariat of the Federal Revenue measuring the total tax burden over the Brazilian economy[9]. Data on tax revenues are presented only at annual frequency and cover the period between 1999 to 2013. Taxes and contributions used to build the dataset in this section are exactly those with information available at higher frequency. Under the criterion of using the same set of taxes and contributions at both frequencies, the final dataset covers, on average, 96.83% of total tax revenues for the period. Compared to the dataset at quarterly frequency, the major difference is related to the concept of tax revenues: monthly time series of tax revenues, used to build the quarterly dataset, show the gross tax revenues; on the other hand, annual reports of the Secretariat of the Federal Revenue show net tax revenues, defined as gross revenues minus refunds. The effects of using gross or net tax revenues are discussed in subsection

[9] Reports in Portuguese named "Carga Tributária no Brasil" available at: http://www.receita.fazenda.gov.br/historico/esttributarios/Estatisticas/default.htm

Table 1: Classification of Taxes and Contributions

Tax	This Study	Pereira (2009)	Lledó (2005)	% Total Revenue*
ICMS, IPI, II and ISS		Consumption		29.2%
Cide	Consumption	Consumption	–	0.7%
Cofins, IOF	Consumption	Capital	Income	12.6%
IRPF		Income		1.1%
IRRF/Remittances and IRRF/Others	Income	–	–	1.6%
PIS / PASEP	Labor	Capital	Income	2.9%
FGTS,RGPS, CPSS(FederalGov.), CPSS (States) and CPSS (Municipalities)		Labor		24.1%
IRRF/Labor	Labor	–	–	4.9%
ES + "S" System	Labor	Capital	Labor	1.6%
IRPJ, CSLL		Capital		9.4%
IRRF/Capital	Capital	–	–	2.8%
ITCMD	Capital	Capital	–	0.1%
ITR, IPVA, CPMF, IPTU and ITBI	Capital	Capital	Income	5.7%

* Average participation of the set of taxes on total revenues over the period 1999-2013.

5.1. There are also few differences related to revenues of municipal taxes and in terms of aggregation of state and federal taxes from monthly time series.

The tax classification used in this study is based on the mapping from the National Accounts presented in Orair et al (2013) [15]. The authors designed a mapping to match the classification recommended in the Government Finance Statistics Manual of the IMF, structured in terms of the base of incidence of the taxes, and the one used in the System of National Accounts, designed by the United Nations. Table 1 presents the classification and highlights the differences with the literature[10], namely the work of Pereira(2009)[16] and Lledó (2005)[10]. The last column of the table 1 shows the average participation of each set of taxes on total tax revenues in the period 1999-2013.

There is a complete agreement on the classification of taxes for almost two-thirds of total tax revenues. Regarding discrepancies on the remaining third of total revenues, a few issues should be highlighted. First, related to the classification of PIS / PASEP, Cofins and IOF, for which there is no agreement between the classification in this study and the other two. Since these three taxes represent, on average, almost 16% of total tax revenues,

[10] Along the text, we use the shortened names of the taxes, but Appendix C presents their complete names in Portuguese and in English, along with a short description.

their classification have a significant impact on the effective tax rates calculated as will be discussed below. With respect to PIS / PASEP, those taxes are indeed social security contributions made by firms in the name of employees. Thus, even if these contributions directly affect firms' profits, they constitute part of the pre-tax labor income from the perspective of the National Accounts. In the case of Cofins, despite being a very similar contribution to PIS / PASEP, the absence of a direct link between the collection of the revenue and the transfer to social security activities might be the reason Orair et al (2013) [15] classified Cofins as a tax on products. The tax base of Cofins is strictly related to firms' revenues and there is no direct return to employees, despite its name suggesting a contribution to social security activities. Finally, IOF is a tax affecting a significant number of financial transactions. Despite the impact on capital allocation, the effects of IOF are mostly noted on the use of payment instruments and their effects on consumption. As a consequence, Orair et al (2013) [15] define IOF as a tax on products, instead of a tax affecting production. Also related to the classification of taxes, while Pereira (2009)[16] defines contributions to the "S" System and Education Salary (ES) as taxes over capital income, this paper follows Lledó (2005)[10] in classifying these contributions as a tax over labor income, since both are based on firms' payroll.

The second discrepancy with respect to the literature is related to data sources: this paper uses disaggregated data on Withholding Income Tax (IRRF), available from Secretariat of the Federal Revenue and published at Ipeadata[11]. With this information, it is possible to separate tax revenues in terms of its incidence over labor and capital income, leaving those from Remittances and Others under the individual income class. Pereira (2009)[16] only uses the aggregate numbers for IRRF, classifying it entirely under the individual income class. Lledó (2005)[10] do not mention including IRRF on their tax revenues classification.

Most of data used to construct the tax base comes from National Accounts, available at the IBGE database[12]. Gross domestic product, private consumption and government spending data come from the expenditures accounts, while wages and salaries (W), gross mixed income (RMB) and the gross operating surplus (EOB) come from the Supply and Use Table ("Tabela de Recursos e Usos", in Portuguese). Unfortunately, the lack of information on factor income from the National Accounts limits the analysis to a span between 1999 and 2009. Data on the compensation of government employees (GW) was constructed with data for payroll and social charges for the three levels of government (Federal, State and Municipal) from Ipeadata.

Table 2 shows average effective tax rates at annual frequency. For comparison, the

[11] Ipeadata is a free dataset mantained by IPEA, a thinktank in economic and social policies mantained by the Brazilian government. The website content is available at http://www.ipeadata.gov.br/.

[12] Available at http://www.sidra.ibge.gov.br/

table also includes values presented in Pereira (2009)[16] and Lledó (2005)[10], combined with a partial sample analysis for each paper: effective tax rates are recalculated using our own dataset, but under the tax classification and time span of each author. The adjustment of dataset closes the gap between estimates in terms of different methodologies, while the adjustment of time span accounts for the dynamics of tax rates.

From results at Table 2, the effective tax rate on consumption (τ_c) is much higher in our study (25.3%), mainly reflecting the classification of IOF and Cofins as consumption taxes. These two taxes have a significant impact in terms of effective tax rates, as they represent, on average, 12.6% of total tax revenues. Under Pereira's (2009)[16] and Lledó's (2005)[10] classification, for the same time span, effective tax rates on consumption in our database become closer to values presented in their work.

Most of the differences observed on individual income taxes (τ_y) reflect different assumptions regarding the tax classification, since the tax base is the same in all three studies. To be more specific, Pereira (2009) does not present his final figures for income tax. However, using our annual dataset, note that the estimated value for income tax considerably increases (from 1.0% to 4.1%) by defining revenues of IRRF under that category[13]. Lledó (2005)[10] obtains the highest tax rate over individual income, as he includes under that category a significant set of taxes, like Cofins, PIS / PASEP and CPMF, representing, on average, 21.3% of total tax revenues. Unfortunately, even after adjusting for Lledó's (2005)[10] classification of taxes, there is a significant gap in terms of effective tax rates on individual income (8.5%, versus 13.4% from our estimates). Most of this gap seems to be related to different figures in terms of total tax revenues[14].

Regarding effective tax rates on labor (τ_l) and capital income (τ_k), there is a significant discrepancy between our figures and the other two. Lledó's (2005)[10] model presents a separate tax rate for social security contributions, resulting in lower labor tax rates overall. On average, General Social Security System (RGPS, in Portuguese) accounts for 15.9% of total tax revenues in the period. Another difference is related to a large group of the taxes classified as capital taxes here and under the individual income class in his work. Even after adjusting for his classification, results in our partial sample analysis are slightly smaller because of discrepancies in estimates of the tax base: Lledó (2005)[10] shows a large share for EOB/Y in 2002, compared to our figures.

The comparison with Pereira (2009)[16] is a little more difficult, as the author do not keep a general income tax as a separate category in the theoretical model, apart from

[13] From Table 1, aggregate IRRF on labor and capital correspond to approximately 7.5% of total tax revenues.

[14] More specifically, figures on the tax burden on individual income tax (IRPF) reported by Lledó (2005)[10] in table A-1 do not match our estimates, suggesting that the author included Withholding Income Tax (IRRF) together with IRPF.

Table 2: Average Effective Tax Rates

	Full Sample: 1999-2009	Pereira (2009): 2001-2005	Partial Sample: 2001-2005	Lledó (2005): 2002	Partial Sample: 2002
τ_c	25.3%	15.9%	17.0%	16.8%	16.3%
τ_y	1.0%	–	4.1%	13.4%	8.5%
τ_l	21.0%	17.6%	14.7%	8.0%	5.9%
τ_k	17.7%	34.5%	30.2%	9.5%	8.8%

labor and capital income taxes. He adopts the methodology of Mendoza et al (1994)[12] of using the general income tax as a first step to compute factor income taxes. The procedure uses the shares of capital and labor in a Cobb-Douglas production function, as defined in section 3.4, to compute the pre-tax income of the economy. The share of the general income tax revenue is added to the tax revenues allocated under each specific class. This methodology generates higher effective rates, as the use of a constant capital share in the tax base and in the general tax revenues implies:

$$\tau_l = \frac{\tau_y (1-\alpha)(W + RMB + EOB) + T_l}{(1-\alpha)(W + RMB + EOB)} = \tau_y + \frac{T_l}{(1-\alpha)(W + RMB + EOB)}$$

$$\tau_k = \frac{\alpha \tau_y (W + RMB + EOB) + T_k}{\alpha (W + RMB + EOB)} = \tau_y + \frac{T_k}{\alpha (W + RMB + EOB)}$$

Another source of discrepancy with Pereira (2009)[16], is related to disagreements in tax classification. First, the specific set of taxes previously discussed in Lledó (2005)[10], classified as a general income tax (IOF, Cofins and PIS / PASEP), are classified in Pereira (2009)[16] as taxes on capital income. Pereira (2009)[16] also includes contributions to the "S" System, and Education Salary (ES) under the same category. Defining all these contributions and taxes as capital income taxes obviously results in higher estimates for tax rates. However, after adjusting for tax classification and the methodology to compute tax rates, the difference between our estimates and the numbers presented in Pereira (2009)[16] are quite small, mostly a consequence of the definition of the tax base.

From the analysis above, it becomes clear that the computation of effective tax rates are very sensitive to the criterion adopted to classify taxes. In this paper, tax classification is based on previous studies where fiscal statistics are in complete agreement with System of National Accounts. This criterion allows for the future development of a coherent framework for fiscal policy analysis, as policy instruments (in this case, taxes) will have a clear link, described in the National Accounts, to macroeconomic aggregates. In the next section, we present the main contribution of this paper, which is the estimation of the effective tax rates at quarterly frequency.

5 Tax Rates at Quarterly Frequency

The main objective of this section is to calculate time series of effective tax rates for consumption, individual, labor and capital incomes at quarterly frequency. While most of the information on tax and contribution revenues at the federal level is available at monthly frequency, the main challenge to compute time series of the tax rates were related to obtaining information on municipal taxes and the contributions for the civil servants' social security system from subnational governments. In terms of the tax base, data of expenditure from the National Accounts are readily available at quarterly frequency, but the Supply and Use Table only provides delayed information at annual frequency. As a consequence, this section also provides details on the procedures adopted to estimate capital and labor compensations and payroll and social charges of subnational governments.

5.1 Data Sources on Tax Revenues

Table 3 presents the dataset on taxes and contributions revenues at monthly frequency considered here, with their respective classification, jurisdiction, data sources and time span. The last column of table 3 shows the average share of each revenue on the total classified revenues. Again, for the sake of reference, this dataset represents 96.83% of total tax revenues of the country. Most of data on federal and state taxes are readily available at the website of Ipeadata. The series of contributions to the FGTS was obtained from the FGTS website[15]. Data on Education Salary (ES) and Contributions to the "S" System are from the Central Bank of Brazil's Time Series Dataset[16]. Data on contributions to RGPS and civil servants' social security contributions of federal government employees (CPSS/Union) are obtained from the monthly report of the National Treasury Secretariat[17].

Most of the problems related to building a dataset on tax and contributions revenues resided on obtaining information on municipal taxes (IPTU, ITBI and ISS) and contributions to the civil servants' social security system of subnational governments – CPSS/State

[15] Available at http://www.fgts.gov.br.

[16] Website: http://www.bcb.gov.br/?TIMESERIESEN. The series is called "Previdência social (Fluxos) – Despesas – Transferências a terceiros" under the identification number 2286. These are contributions that the National Institute of Social Security (INSS, in Portuguese) collects and transfers to the respective entities.

[17] Available at www.tesouro.fazenda.gov.br/resultado-do-tesouro-nacional.

Table 3: Data on Tax Revenues at Monthly Frequency

Tax	Class	Jurisdiction	Data Source	Data Interval	% Total Revenue*
IPI, Imports, Cide, Cofins and IOF	τ_c	Federal	Ipeadata	Jan/99–Dez/14	19.3%
ICMS	τ_c	State	Ipeadata	Jan/99–Dez/14	22.6%
ISS	τ_c	Municipal	SISTN FINBRA	Jan/06–Dez/14 1999–2014	2.3%
IRPF, IRRF/Remittances and IRRF/Others	τ_y	Federal	Ipeadata	Jan/99–Dez/14	2.9%
FGTS	τ_l	Federal	FGTS website	Jan/99–Dez/14	5.1%
IRRF/Labor and PIS / PASEP	τ_l	Federal	Ipeadata	Jan/99–Dez/14	8.1%
ES and "S" System	τ_l	Federal	BCB	Jan/99–Dez/14	1.5%
RGPS and CPSS/Federal	τ_l	Federal	RTN Annex	Jan/99–Dez/14	18.1%
CPSS/State	τ_l	State	SISTN	Jan/99–Dez/14	0.6%
CPSS/Municipal	τ_l	Municipal	SISTN	Jan/99–Dez/14	0.2%
IRPJ, CSLL	τ_k	Federal	Ipeadata	Jan/99–Dez/14	10.3%
ITR and IRRF/Capital	τ_k	Federal	Ipeadata	Jan/99–Dez/14	2.9%
CPMF	τ_k	Federal	Ipeadata	Jan/99–Mar/12	2.3%
IPVA and ITCD	τ_k	State	Ipeadata	Jan/99–Dez/14	1.8%
IPTU and ITBI	τ_k	Municipal	SISTN FINBRA	Jan/06–Dez/14 1999–2014	1.8%

* Average participation of the set of taxes on total tax revenues over the period 1999 - 2014.

and CPSS/Municipal. The next subsections discuss: (i) the details of the procedure to reconcile the few public datasets available on subnational government spending and revenues; (ii) the final information set on tax revenues at quarterly frequency.

5.1.1 Subnational Governments Data Construction Using SISTN

Every year, the National Treasury Secretariat publishes a large dataset called FINBRA[18], with information on the annual balance of municipalities. Municipalities are required to report detailed information, otherwise being subject to sanctions to finance debt in financial markets[19]. The dataset consolidated by the National Treasury Secretariat provides details on tax collection, but unfortunately misses information on social security contributions and government employees payroll. One of the main sources of information to FINBRA is a system called SISTN ("Sistema de Coleta de Dados Contábeis dos Entes da Federação", in Portuguese), created in 2000 and with detailed information starting in 2006. Municipalities are required by law to send periodical reports to this system, where those reports are made available for public consultation[20].

One report submitted by states and municipalities to SISTN is particularly important for our purposes: a simplified bimonthly report called RREO (Summary Report of Budget Execution, "Relatório Resumido de Execução Orçamentária", in Portuguese) provides details on the main taxes and contributions collected at subnational level. Although RREOs are submitted bimonthly, the information on taxes and contributions are presented at monthly frequency for the previous 12 months. RREOs also provide information on civil servants' social security contributions, at monthly frequency, and on government employees payroll and social charges, at bimonthly frequency[21].

Unfortunately, it is not possible to extract from SISTN a single report consolidating information over time or across subnational entities. In order to work with SISTN, it was necessary to build a system capable of downloading reports in PDF format for every individual subnational government entity, for every period of time; convert the PDF reports to a format able to read and process the information in those reports; and compile the final dataset, summarizing information from all reports. This process demanded a significant computational effort, where three VBA routines were developed to handle the first two tasks. The first routine was built to download the correspondent PDF file for

[18] Available at http://www.tesouro.fazenda.gov.br/en/contas-anuais.

[19] The requirement of sending reports to the Federal Government is described in sections II, III and IV of the Fiscal Responsibility Law (Complementary Law 101, of May 4^{th}, 2000).

[20] Available at https://www.contaspublicas.caixa.gov.br/sistncon_internet/index.jsp . See footnote 1 about the modernized system implemented by the National Treasury.

[21] Details on how we handle bimonthly information on payroll and social charges are presented in subsection 5.2.1.

each RREO, for the 5568 municipalities, 26 states and the Federal District[22], from 2006 to 2014[23]. The second routine reads every PDF file and converts the information to TXT files. The third routine reads the TXT files and extracts only information on tax revenues, government spending and social security contributions to build the aggregate dataset.

In order to evaluate the quality of the data on municipal taxes revenues (IPTU, ITBI and ISS) collected from SISTN, Table 4 presents the annualized data from SISTN between 2006 and 2014 and the values reported for every year in FINBRA. It also shows the number of municipalities, including the Federal District, that have information on FINBRA and submitted a valid report[24] on SISTN. The coverage of FINBRA database (on average, 94.8%, 94.1% and 96.5%, for IPTU, ITBI and ISS, respectively) is larger than the coverage observed on SISTN (on average, 71.1%, 71.8% and 72.7%, for IPTU, ITBI and ISS, respectively). In terms of number of municipalities reporting information, both databases show a decrease in participation rate over the years, with a more accentuated fall in SISTN.

The decline in the number of municipalities reporting information to SISTN and FINBRA does not correspond to a decline in the ratio of aggregate taxes reported to SISTN over taxes presented in FINBRA. That means, even with a significant decline in the number of cities providing reports to SISTN, relative to those presenting information to FINBRA, the loss in terms of aggregate taxes does not seem to be significant. The main reason for that is the unequal distribution of tax collection across municipalities, with a small number of large cities (in terms of population size) generating a large share of total tax collection. Figure **1** summarizes the information on the distribution of taxes based on city's population and the precision of SISTN data, compared to data on FINBRA. The first row of graphs in figure **1** shows that, on average, municipalities with at least 100,000 inhabitants – 299 cities – collect 86% of total IPTU and ISS revenues and 80% of total ITBI revenue. Moving one step further, municipalities with at least 50,000 inhabitants – 638 cities – collect, on average, 92% of total IPTU revenues, 91% of total ISS revenues and 87% of total ITBI revenues.

The second row of graphs in figure **1** shows that, despite the unequal distribution of tax collection across cities, data seem to have good quality, as the discrepancy between

[22] The Federal District is a special subnational entity that includes the Nation's capital. Its organization in terms of taxes is similar to a state without municipalities: the Federal District's Government (GDF, in portuguese) collects all taxes that other states in the country are able to collect, plus municipal taxes like IPTU, ITBI and ISS. GDF reports all tax revenues on its RREOs. This data was checked for consistency with information from the annual balance of GDF.

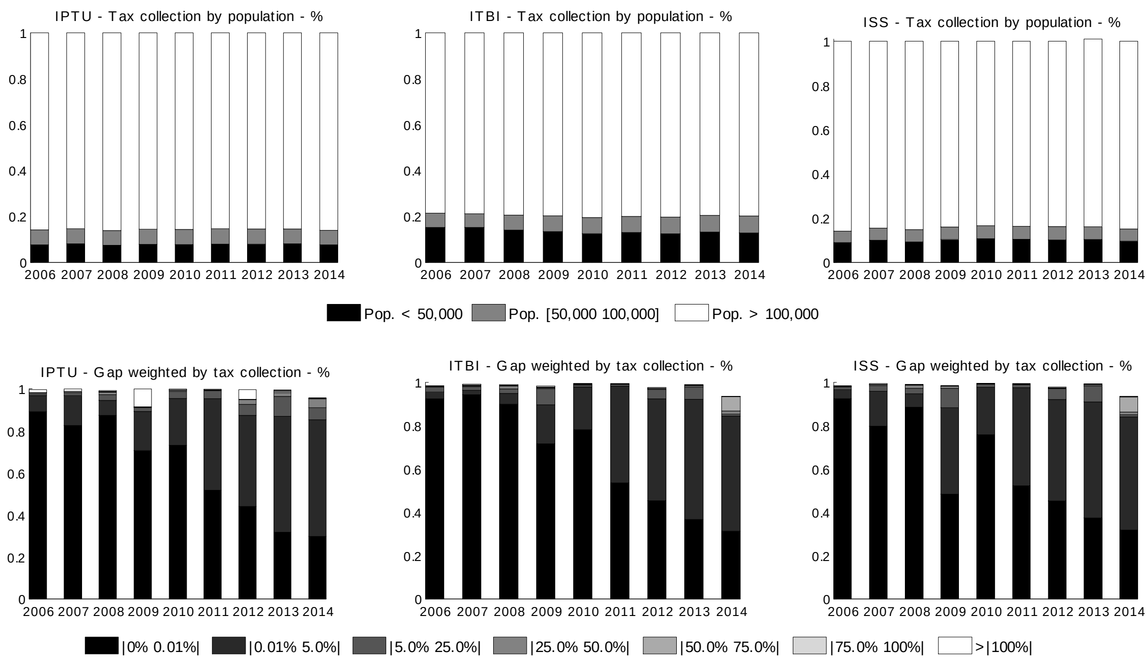
[23] This gaves us 192,318 reports for municipalities and 1,289 reports for the states and the Federal District.

[24] Here, an RREO is considered a valid report for the analysis, if there is at least a non-zero entry for a given tax in any month of the year. If the municipality reported only zeros as the tax collection for a full year, it is considered as an invalid/missing report.

Table 4: Comparison of Annual Data from FINBRA with Annualized Data from SISTN

	2006	2007	2008	2009	2010	2011	2012	2013	2014
IPTU (in R$ millions)									
FINBRA	10,872.3	11,907.8	12,725.2	14,177.5	16,362.7	18,378.3	20,245.6	22,631.2	24,133.5
# municipalities	5,268	5,359	4,947	5,382	5,401	5,271	5,089	5,185	4,288
(% of total)	94.6%	96.2%	88.8%	96.6%	97.0%	94.7%	91.4%	93,1%	77,0%
SISTN	10,759.5	11,580.3	12,691.6	15,198.8	16,181.5	18,134.8	20,890.5	21,948.4	23,089.7
# municipalities	4,213	4,185	4,135	4,107	4,058	3,979	3,906	3637	2821
(% of total)	75.7%	75.1%	74.3%	73.7%	72.9%	71.4%	70.1%	65.3%	50.7%
Adjusted IPTU	10,912.6	11,914.5	12,824.0	14,186.5	16,384.9	18,413.1	20,322.8	22,753.5	25,510.5
ITBI (in R$ millions)									
FINBRA	2,451.7	3,203.4	3,966.4	4,167.5	5,569.8	6,865.5	7,886.0	9,335.7	9,437.2
# municipalities	5,249	5,315	4,907	5,356	5,354	5,212	5,020	5190	4282
(% of total)	94.3%	95.4%	88.1%	96.2%	96.1%	93.6%	90.1%	93.2%	76.9%
SISTN	2,531.1	3,131.2	3,942.6	4,103.5	5,446.1	6,699.3	7,911.5	9,105.4	8,488.6
# municipalities	4,522	4,128	4,079	4,036	4,002	3,894	3,831	3646	2863
(% of total)	81.2%	74.1%	73.2%	72.5%	71.9%	69.9%	68.8%	65.5%	51.4%
Adjusted ITBI	2,468.0	3,226.6	4,012.4	4,178.6	5,576.2	6,882.1	8,030.7	9,457.7	9,865.7
ISS (in R$ millions)									
FINBRA	16,868.5	19,749.4	23,403.3	26,086.7	31,335.3	36,532.4	42,204.7	45,835.6	47,754.1
# municipalities	5,422	5,513	5,050	5,487	5,470	5,339	5,161	5323	4391
(% of total)	97.4%	99.0%	90.7%	98.5%	98.2%	95.9%	92.7%	96.6%	78.8%
SISTN	17,178.4	19,045.6	23,005.7	25,225.3	30,326.7	35,248.6	41,360.3	44,313.1	43,508.6
# municipalities	4,638	4,201	4,149	4,099	4,049	3,941	3,909	3691	2899
(% of total)	83.3%	75.4%	74.5%	73.6%	72.7%	70.8%	70.2%	66.3%	52.1%
Adjusted ISS	17,070.3	19,753.0	23,682.3	26,134.2	31,367.6	36,582.6	42,539.2	46,216.4	50,181.3

Figure 1: Local Taxes – Distribution by population size
and Weighted Difference SISTN-FINBRA

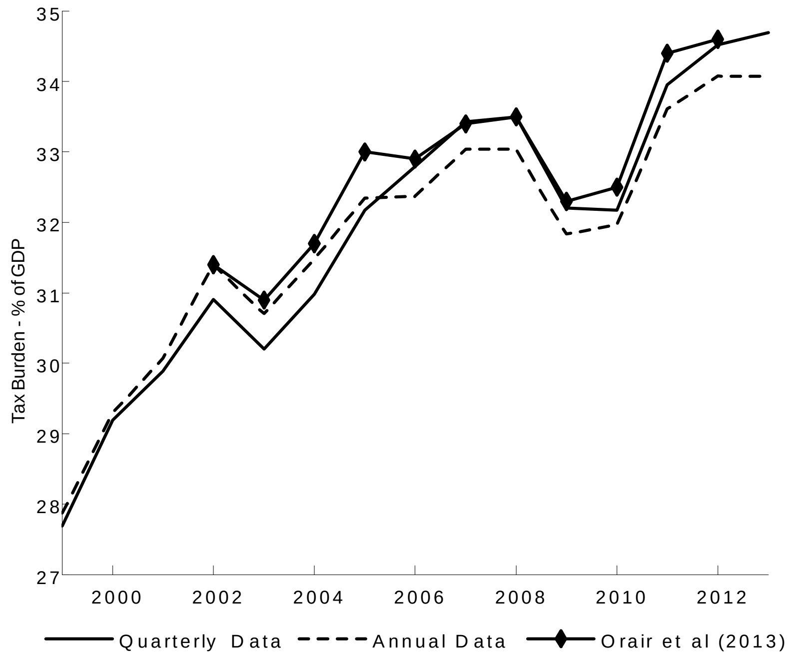


FINBRA and SISTN data, weighted by city's share of total tax collection, is very small. More than 90% of the cumulative annual value of taxes in SISTN have an error between zero and 5%, compared to information from FINBRA. In a more restrictive perspective, between 2006 and 2007, more than 80% of the tax collection has an error smaller than 0.01%. The share of tax collection with gaps smaller than 0.01% between FINBRA and SISTN has decreased over time, but still remains above 30% in 2014.

Table 4 also shows an additional row for each tax, reporting an adjusted value of total tax revenues. The adjusted revenues measure the aggregate tax collection for a given year, after taking into account the difference in aggregates reported in SISTN and FINBRA for each municipality. The main idea of this adjustment is to distribute, for each municipality, the difference between the annual data from FINBRA, assumed here as a more precise estimate of revenues, and the 12-month accumulated data from SISTN according to the average tax collection in each month of the year. The details of this adjustment are presented in Appendix D.

The final quarterly dataset is compared in figure **2** with the values presented in Orair et al (2013)[15]. The authors constructed a similar computational system to collect data from SISTN and computed the tax burden over the Brazilian economy at monthly frequency for the period 2002-2012. The main difference between Orair et al (2013)[15] and the procedure described here so far is related to the treatment applied to tax revenues of

Figure 2: Tax Burden
Annual and Quarterly Datasets x Orair et al (2013)



subnational governments. The authors use temporal disaggregation and contemporaneous forecasts through state-space econometric models to estimate the relevant series. Despite the lack of advanced econometric techniques, the final time series on aggregate tax burden computed here is not far from the information published in Orair et al (2013)[15]. On average, our estimates of the total tax burden (total tax revenues as a proportion of GDP) is 0.55p.p. below their estimate for the period between 2002 and 2012[25]. The main differences between the quarterly and annual estimates presented here and the values presented in Orair et al (2013)[15] is related to the period before 2006, when information from SISTN is not available to complement missing information on FINBRA. Note that, for the period between 2002 and 2006, when only the annual dataset is comparable to Orair et al (2013)[15], the total tax burden is very similar, both in terms of levels and dynamics. After 2006, with the adjustments on revenues using SISTN and the availability of information on contributions, the quarterly dataset tracks better the results of Orair et al (2013)[15].

Besides data for municipal taxes revenues, RREOs collected from SISTN also offer information on civil servants' social security contributions in states and municipalities

[25] In March/2015, the National Accounts went through a major revision. The estimates presented in this paper use the revised numbers. However, in Figure **2,** in order to keep the estimates comparable to those presented by Orair et al (2013) [15], the unrevised GDP numbers were used to compute the series for the tax burden, both at annual and quarterly frequency.

(CPSS/States and CPSS/Municipal). Unfortunately, to the best of our knowledge, there is not an annual dataset disaggregated by states and municipalities similar to FINBRA available to check the accuracy of reports. The only source of information on CPSS/States and CPSS/Municipal are the annual aggregated figures published by the National Treasury Secretariat and the Secretariat of Federal Revenue. Given this limitation, the adjustment made on tax revenues using information from FINBRA was not repeated for contributions of civil servants. Even without the adjustment, however, the comparison of annual values from the National Treasury with figures from SISTN shows a small gap between the two time series. Notably, the gap observed for Municipal contributions is much smaller than the one obtained for States.

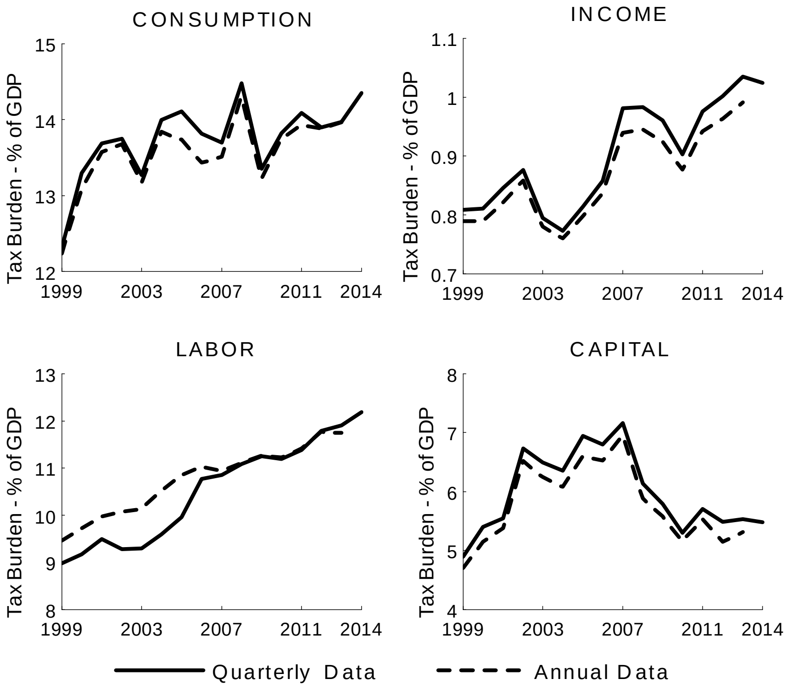
Another problem with information from CPSS is the lack of disaggregated data for CPSS/States and CPSS/Municipal for the period before 2006. The short time span with information available at monthly frequency after 2006, combined with the lack of alternative datasets to check the accuracy of the procedure, suggests that it would not be a good strategy to distribute aggregated annual data over monthly information. The effects of missing high-frequency information for CPSS/States and CPSS/Municipal are discussed next.

5.1.2 Tax Revenues Series

Given the procedure described above to collect information from different datasets, we were able to construct monthly time series on taxes and contributions revenues for each class of tax (T_c, T_y, T_l and T_k). Figure 3 compares the total tax burden for each class of taxes as a share of GDP using annual and quarterly data. The annualized, 4-quarter accumulated tax burden series are in general not too far from the annual series. In fact, taxes on consumption, individual income and capital income from the quarterly dataset are consistently above the annual estimates, with a stable gap separating time series at different frequencies. The gap between annual and annualized time series is a consequence of two factors: first, as briefly discussed above, the use of net taxes revenues in the annual reports of the of the Secretariat of the Federal Revenue, instead of gross tax revenues as published in monthly reports; second, the adjustment of SISTN data to information from FINBRA, which usually generated higher aggregate estimates of tax revenues of municipalities, as shown in table 4.

The most important differences between annual and quarterly estimates are related to the estimates of labor tax revenues for the period between 1999 and 2006. This gap is a consequence of the lack of data on CPSS/States and CPSS/Municipal at monthly frequency for that period, plus some discrepancies in monthly information for contributions to the "S" System. The average impact of missing information on these taxes, specially

Figure 3: Tax Burden by Tax Class



on CPSS/States and CPSS/Municipal, despite representing a small share of total tax revenues[26], on the total tax burden is estimated at 0.7p.p. of GDP.

Figure 3 shows an increase in the total tax burden over the Brazilian economy observed in the last 16 years, based on the increase in tax revenues obtained from all sources. The total tax burden increased around 6p.p. of GDP between 1999 and 2014, mostly concentrated on labor (3.1p.p. of GDP) and consumption (2.0p.p. of GDP) taxes. After the 2008 financial crisis, the burden fell for all classes of taxes, as the adoption of an expansionary fiscal policy, based on selective tax rates cuts, combined with the natural decrease in tax revenues due to slower economic activity, resulted in a temporary reduction of tax burden as a proportion of GDP. Consumption taxes observed a significant drop right after the crisis, but it has already returned to its pre-crisis values. In a smaller scale, this temporary drop was also observed in individual income and labor tax burdens, with a quick recovery of their upward trends. The same did not happen to the burden of tax on capital income. It increased 2.3p.p of GDP until 2007, followed by a significant and persistent decrease after the crisis. The beginning of the crises, however, coincides with the extinction of CMPF in 2008. The burden of this tax alone represented on average 1.3p.p. of GDP between 1999 and 2007. An evaluation of the tax burden on capital income, without including CPMF in the analysis, shows that the tax burden returned to

[26]CPSS/States and CPSS/Municipal represent 1.4% and 0.4%, respectively, of average total tax revenues, according to table 3.

its pre-crisis level by 2014.

5.2 Data Sources on the Tax Base

Two main sources were used to compute the tax base at quarterly frequency, given the definitions presented in equations 4, 9, 11 and 12. First, to compute consumption taxes, as in the case of effective taxes computed with annual data, the main source is the National Accounts. Then, to compute factor income, population surveys are used to make inference on total labor income. Beyond describing details of these two sources, this section presents, first, the computation of government employee's compensation at quarterly frequency. After that, the details on the use of population surveys to estimate labor and capital income are presented.

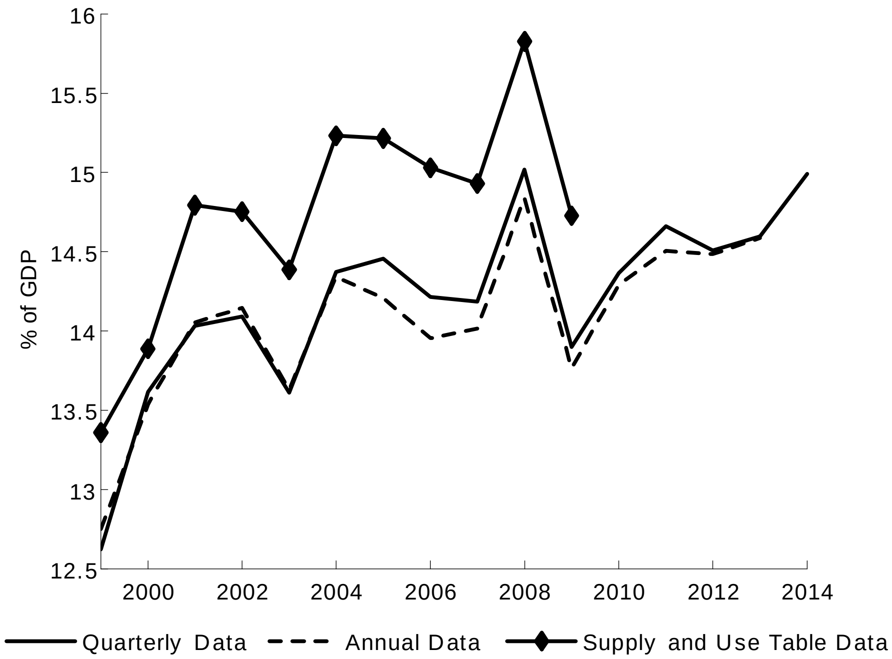
From the National Accounts perspective, beyond information on gross domestic output, private consumption and government spending, it is necessary to build an estimate of the economy's value added at factor costs. As in the case of labor and capital income, official estimates available for the value added at factor costs are available only at annual frequency and without constant updates. By the definition presented in equation 8, value added at factor costs is computed by the difference between net domestic income and an estimate of "net taxes on production". While estimates of the gross domestic product are readily available, an approximation of "net taxes" is constructed, based on the definitions of Orair et al (2013)[15], as the sum of IPI, ICMS, ISS, CIDE, II, IOF, Cofins, ES and contributions to the "S" System. Figure 4 compares this approximation with information on "taxes on production" from the Supply and Use Table, both measured as a proportion of GDP. Our estimates based on quarterly data are, on average, 0.7p.p. below of the Supply and Use Table, showing good accuracy, even with the problems reported before on the database for quarterly data.

After generating an estimate of total factor income, $W + RMB + EOB$, by using gross domestic product, $Y - Net\ Taxes$, the next two subsections show the procedure to construct time series for government employees' compensations, GW, and for labor and capital income. Table 5 summarizes the data sources used to construct the series on the tax base.

5.2.1 Constructing a Series for Government Employees' Compensations

In order to construct a quarterly time series on government employees' compensations (GW in equation 4), information from SISTN was used to estimate figures for subnational entities of the federation. Datasets from the National Treasury Secretariat provided annual information on payroll and social charges for the three levels of government.

Figure 4: Net Taxes
Annual and Quarterly Datasets x Supply and Use Table Data



Information for the Federal Government is available at monthly frequency on Ipeadata. However, high-frequency data for States and Municipalities is not readily available – thus, the need to use SISTN again.

The procedure to collect data from SISTN is the same described in Section 5.1.1, with one caveat associated with data frequency: each RREO only has the information on payroll and social charges for the bimester it refers to. RREOs do not provide a monthly series for the 12 previous months, as it is the case for tax revenues and social security contributions. For municipalities, annual data from FINBRA was used to adjust the series as in the case with municipal taxes. The same adjustment was performed with the time series for States, comparing with the annual data provided by the National Treasury Secretariat in the Report of Budget Execution of the States[27]. Details of the adjustment, also related to the generation of quarterly time series using the bimonthly data, are provided in Appendix D. Table 6 presents a summary of the information obtained from SISTN.

[27] Available at https://www.tesouro.fazenda.gov.br/execucao-orcamentaria-dos-estados

Table 5: Data on Tax Base Components

Component	Frequency	Data Source	Data Interval
Y, C, G	Quarterly	IBGE	1999.T1 - 2014.T4
Payroll and Social Charges Federal Government	Monthly	Ipeadata	1999.01 - 2014.12
Payroll and Social Charges	Bimonthly	SISTN	2006.B1 - 2014.B6
State Governments	Annually	National Treasury	1999 - 2013
Payroll and Social Charges	Bimonthly	SISTN	2006.B1 - 2014.B6
Municipal Governments	Annually	FINBRA	1999 - 2014
Labor and Capital Income	Monthly	PME, PNAD and Census (IBGE)	1999.01 - 2014.12

5.2.2 Constructing the Series on Labor and Capital Income

National Accounts in Brazil do not provide quarterly information on labor and capital income[28]. As mentioned in subsection 3.5, in order to compute average income taxes rates at quarterly frequency, information from population surveys in Brazil is used to build an approximation of total labor income ($WI + FC$, defined in equation 10). According to equation 12, capital income is calculated as a residual from value added at factor cost, $Y - Net\ Taxes$, and total labor income.

Total labor income is defined as the sum of wages and salaries and the employer's contribution to social security system[29]. The information on employer's contribution to social security system, FC, is available at monthly frequency, after a few assumptions on the contribution of subnational governments. Hence, the major issue is related to the estimate of wages and salaries, WI, for Brazil at a higher frequency. The procedure adopted to build this time series is based on two steps: first, estimate the total occupied population in Brazil, using information from two surveys (PME and PNAD); then, calculate an approximation of average wages for Brazil, after combining information from three surveys (PME, PNAD and Census of Population).

The combination of three surveys to obtain an estimate of total labor income for Brazil is necessary because of the sample coverage and the frequency of each survey. At monthly frequency, PME survey ("Pesquisa Mensal de Emprego", in Portuguese) provides data on employment and wages for six metropolitan areas of the country[30], representing 25% of total Brazilian population. PNAD survey ("Pesquisa Nacional por Amostra de Domicílios", in Portuguese), provides information on employment and wages sampled for the whole country, but only at annual frequency. Besides, for censitary years (2000 and

[28] As of today, the latest information on income distribution between labor and capital from the National Accounts is available at annual frequency and updated until 2009.

[29] See IBGE (2008)[9], page 67.

[30] Recife, Salvador, Belo Horizonte, Rio de Janeiro, São Paulo and Porto Alegre.

Table 6: Comparison of Annual Data with Annualized Data from SISTN

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Payroll & Social Charges - States (in R$ millions)									
Treasury	124,592.1	141,192.0	159,408.4	172,128.8	197,557.0	226,181.8	265,332.7	319,397.9	NA (1)
SISTN	124,100.1	131,282.9	139,662.7	145,091.8	164,601.4	196,630.3	224,394.7	272,656.4	305,362.0
SISTN/Treasury	99.6%	93.0%	87.6%	84.3%	83.3%	86.9%	84.6%	85.4%	-
Adjusted	124,592.1	141,192.0	159,408.4	172,128.8	197,557.0	226,181.8	265,332.7	319,397.9	305,362.0
Payroll & Social Charges - Municipalities (in R$ millions)									
FINBRA	77,882.9	90,488.4	101,323.3	118,104.9	134,819.3	155,809.3	177,005.2	199,409.1	203,419.8
# municipalities	5,422	5,521	5,049	5,426	5,417	5,317	5,150	5,094	4,328
(% of total)	97.4%	99.2%	90.7%	97.4%	97.3%	95.5%	92.5%	91.5%	77.7%
SISTN	77,168.9	79,179.2	90,925.3	101,678.5	113,975.4	129,039.4	141,288.5	161,403.7	158,791.4
# municipalities	4,382	4,331	4,254	4,192	4,103	4,030	3,940	3,732	3,247
(% of total)	78.7%	77.8%	76.4%	75.3%	73.7%	72.4%	70.8%	67.0%	58.3%
SISTN/FINBRA	99.1%	87.5%	89.7%	86.1%	84.5%	82.8%	79.8%	80.9%	78.1%
Adjusted	78,439.5	90,550.1	104,556.2	120,442.6	136,784.5	157,518.8	179,866.2	204,834.8	220,506.1

(1) Data from the Treasury not available for 2014 yet. Information from SISTN without adjustment was used.

2010 in our time span), PNAD survey is not available[31].

Data from Census of Population also alleviates a problem related to the estimate of average wages in Brazil. In the literature, Gomes, Bugarin and Ellery (2005)[8] compare data from PNAD and the annual data on labor income presented in the National Accounts. They estimate total labor income using PNAD data and suggest that, between 1992 and 1998, aggregate labor income was actually 26% higher than the number presented in the National Accounts. Census data provide greater coverage when compared to PNAD, allowing for corrections on the measurement of average wages when the income distribution is very skewed, as discussed later.

Proceeding with the estimation of total employed population in Brazil, assume that the short run dynamics of employed population in the metropolitan areas covered by PME is the same as the dynamics for the whole country[32]. The time series of employed population is adjusted twice: first, by the gap generated from the difference in the definition of employed people between PNAD and PME; second, by the share of employed population in the region covered by PME over total employed population in Brazil. For the first adjustment, the average ratio between 1999 and 2013 of employed population in PME over employed population in PNAD is estimated at 0.94. This ratio is quite stable over the sample, especially after 2002. For the second adjustment, the average share between employed population in metropolitan areas of PME and PNAD survey is estimated at 0.246. The two ratios are uniformly applied over the PME time series of employed population described above.

For a quarterly estimate of average wages for Brazil, assume, again, that the short run dynamics of wages for the whole country is the same as the dynamics described by data from PME[33]. Starting from PME dataset, three adjustments are performed: (*i*) for the period between 1999 and 2002, adjust old data from PME to the average value of wages for all occupations, instead of wages from the main occupation; (*ii*) estimate the average gap between wages in PME and the values reported in Census for the same geographical area, in order to correct the level of wages for differences in income distribution; (*iii*) estimate wages for Brazil, taking into account the gap between the metropolitan areas surveyed by PME and the whole country. These three steps are detailed below.

[31] PME, PNAD and Census microdata are obtained from the IBGE's website (http://www.ibge.gov.br).

[32] There was a methodological change in the definition of work, among other issues, in PME in 2002. For the period between 1999 and 2002, the number of employed people is simply a retropolation of the new definition of employed population over percentual changes of employed population observed in the old survey methodology.

[33] As we are interested in total labor income, wages here are defined as "wages effectivelly accrued by household" in each month. However, in order to compare the same variable across surveys, ratios presented next relates to "wages usually accrued by household". This is the measure of income surveyed in PNAD and Census, and it is different from the former measure because it does not include bonuses and other temporary compensations for the household.

Table 7: Average Wage – Census and PME

	Value (in R$)	Gap
PME – Jul/2000 – Main Occupation	723.91	18.8%
Census 2000 – Main Occupation	860.22	
PME – Jul/2010 – Main Occupation	1452.50	11.2%
Census 2010 – Main Occupation	1615.84	
PME – Jul/2010 – All Occupations	1484.45	13.0%
Census 2010 – All Occupations	1681.33	
Average		14.4%

In terms of the first adjustment, PME data for the period between 1999 and 2002 did not include information on wages for all occupations of the household. Instead, data available refers only to wages for the main occupation. Using data from PNAD between 1999 and 2013, restricted to cover only PME survey's metropolitan areas, the average gap between the income of all occupations and the income of the main occupation is estimated at 3.1%. This factor multiplies wages for the period between 1999 and 2002, as an estimate of average wage for all occupations of the household.

For the second adjustment, table 7 compares average earnings from PME and from the 2000 and 2010 Census, computed at the same metropolitan areas of PME, at the reference month of each Census[34]. There is a significant discrepancy in average wages, probably related to the large wage income inequality in Brazil and the difficulty of small surveys to capture accurate information at the highest income levels[35]. Evaluation of survey's microdata shows that the gap between PME and Census income estimates, at the same percentile, are generally increasing, as the top of the distribution is reached. Thus, at the median, the gap between income reported at the Census versus the income reported at PME reaches 6%; at the 90th percentile, the same gap is estimated at 17%; at the 99th percentile, the gap reaches 30%; and so on. Given this fact, the first transformation applied to average wages data in PME is to adjust by the average gap between wages reported at Census and PME survey.

For the third adjustment, one important feature of labor income distribution in Brazil is related to wage growth in the metropolitan regions versus wage growth in other regions. There is a decreasing gap between wages outside the metropolitan areas surveyed by PME

[34]Note, again, that PME only started presenting data on average wages from all occupations of the household in 2002.

[35]Unfortunately, research on income distribution using information from tax reports is still very preliminary in Brazil. Those results show that even data from Census might significantly underestimate total labor income: Medeiros, Souza and Castro (2014)[11] estimate that the top 1% of population in terms of income accrues a share of 25% of total income in the economy; in the 2010 Census, this number is estimated at 20%.

Table 8: Average Wage – All Occupations of Household
PNAD Survey

	PME Areas (in R$)	Brazil (in R$)	Gap
1999	691.60	449.83	53.7%
2001	779.43	525.07	48.4%
2002	820.26	560.54	46.3%
2003	875.03	610.54	43.3%
2004	902.96	644.72	40.1%
2005	1013.17	704.50	43.8%
2006	1095.32	782.09	40.1%
2007	1171.95	850.73	37.8%
2008	1251.00	936.37	33.6%
2009	1350.28	1005.96	34.2%
2011	1672.71	1239.50	35.0%
2012	1844.53	1389.40	32.8%
2013	2069.42	1526.70	35.5%
Average			40.4%

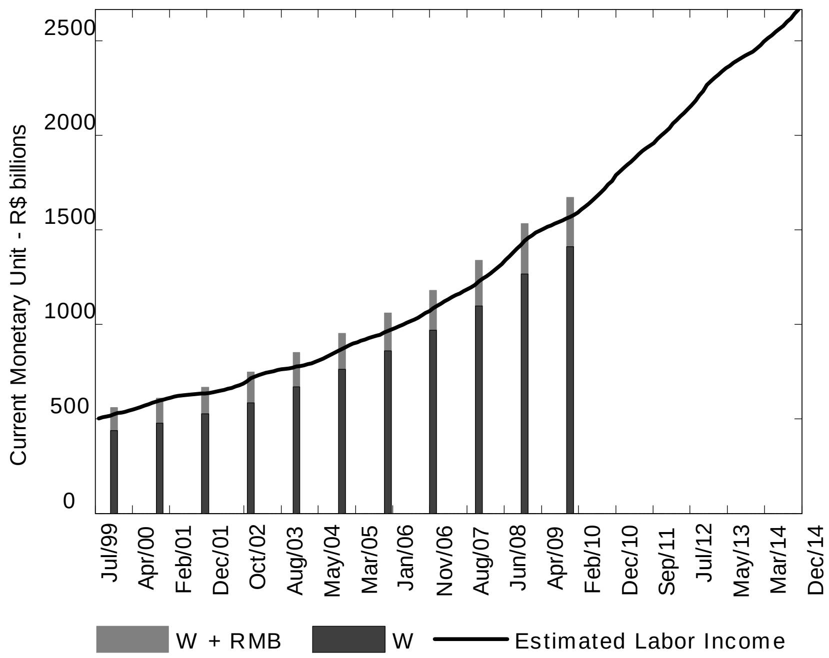
and wages in the rest of the country, according to data from PNAD survey. Table 8 shows the ratio of the average wages in metropolitan areas of PME over wages in Brazil from 1999 to 2014. The gap between wages in metropolitan areas surveyed by PME and for the whole country decreases from 53.7% in 1999 to 35.5% in 2013[36]. In order to adjust for this trend, the estimated gap presented in table 8 is linearly interpolated over the years and applied over the estimated wages after the two procedures described before.

The set of adjustments incorporated above to estimate wages for Brazil shows that using only PNAD data to correct estimates of average wages for the effects of the tails of the wage distribution might not be sufficient, as the estimated time series is systematically above the average values reported in PNAD survey. Our results, in fact, suggest that the underestimation of aggregate labor income found in Gomes, Bugarin and Ellery (2005)[8] might be even more significant than what they report.

The final step to compute total labor income consist of adding estimates of total employer's contribution over wages and salaries estimated above, as described in the methodology of IBGE[9] for the labor income in the National Accounts. The employer's share of contributions inputted over wage income is based on information for FGTS, PIS/PASEP, ES, "S" System, RGPS and CPSS. While the first four contributions are entirely paid by employers, it was necessary to collect information on the employer's share of total RGPS and CPSS tax collection. Using reports from the official Social Security

[36] This trend is also significant if data is restricted to average wage only in the main occupation of the household or comparing data from the 2000 and 2010 Census.

Figure 5: Labor Income Estimate
National Accounts and High-Frequency Values



System in Brazil, we were able to identify the employer's contribution to the system. In terms of CPSS, we were able to collect information at the Federal level of government for the share of employer's contribution. For the sake of simplicity, we assume that, at the subnational government level, the share of employer's contribution to CPSS is the same as in the Federal level.

Figure 5 shows the estimated path for the 12-months cumulative labor income, comparing results with the usual metric adopted to estimate total labor income: using only employees compensation (W) and the sum of employees compensation and the income of autonomous workers ($W + RMB$, from the Supply and Use Table). While the first measure is adopted in Mendoza et al (1994)[12], the second measure is proposed in Considera and Pessoa (2011)[6]. Our methodology focused only on the definitions of labor income from the National Accounts and information available from microdata of population surveys. Our estimates of labor income stays really close to the measure proposed in Considera and Pessoa (2011)[6].

5.2.3 Summary of Tax Base Data

In order to compute the tax base for quarterly estimates of effective taxes, it was necessary to collect information matching variables described in equations from sections 3.2 and 3.4. As a summary, the procedure to compute the tax base was the following:

- For the tax base of consumption, data from the National Accounts and quarterly estimates of tax revenues on consumption and government employees' compensations, presented in sections 5.1 and 5.2.1, respectively, were used to compute $C + G - GW - T_c$.

- The tax base on income tax is given by the pre-tax value of total income, $Y - Net\ Taxes$, computed at quarterly frequency.

- For taxes on labor, we estimated the wage received by households using population surveys, WI, and, following the procedure in the National Accounts, included the revenues on contributions charged on employers, FC. Both series were calculated using monthly data and converted to quarterly frequency.

- Finally, for taxes on capital, the tax based is expressed as the difference between the pre-tax total value added at cost factor and the estimate of labor income, computed at quarterly frequency: $KI = Y - Net\ Taxes - WI - FC$.

5.3 Effective Tax Rates - Quarterly Data

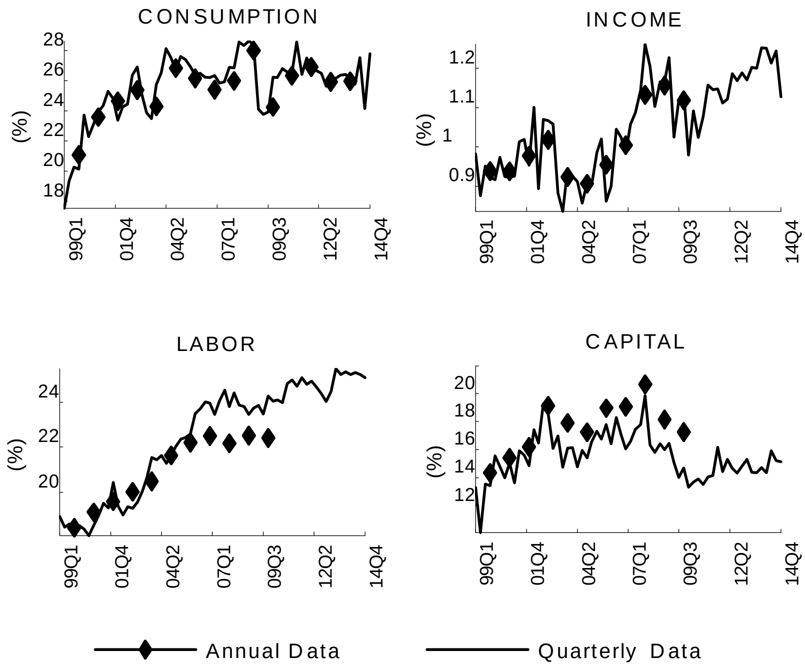
Effective tax rates are, finally, computed after obtaining information on tax revenues and the tax base. The only additional procedure adopted to smooth the dynamics of tax rates is the removal of seasonal components from tax revenues and the tax base. From the perspective of the tax revenues, removing the seasonal component smooth spikes associated with regular annual dates for the collection of certain taxes. Also, from the perspective of the tax base, removing the seasonal component avoids distortions generated from regular components of income. For instance, labor income is severely distorted when households receive annual bonuses, like the "13^{th} wage", usually at the end of calendar year.

Figure 6 shows quarterly time series for each effective tax rate (τ_c, τ_y, τ_l, and τ_k) along with those computed at annual frequency[37]. In general, quarterly series are not too far from the annual rates, even with discrepancies with respect to the tax base and some tax revenues in the two frequencies. As expected, most of the differences are observed in labor and capital income taxes, where the problems related with the collection of information on revenues and the tax base are more evident.

In terms of results, the time series confirm the general idea of an increase in effective tax rates for the Brazilian economy over the last 16 years. This trend was partially

[37] Appendices A and B show the time series for each average effective tax rate discussed, respectively at annual and quarterly frequencies. Additionally, there is also a time series of average effective tax rate for general income taxes, assuming that it is not possible to discriminate the source of income. Using the notation of section 3.1, the time series assumes a model where $\tau_y = \tau_k = \tau_l$ in every period.

Figure 6: Effective Tax Rates by Class
Annualized Data x Annual Data



interrupted after the 2008 international crisis. However, at the end of the sample, the trend seems to have recovered its path, especially for tax rates on capital and individual incomes. It is also interesting that the crisis period is also characterized by a break of the trend for labor income taxes, but not a downward movement in tax rates, as observed on individual income, consumption and capital income taxes.

6 Empirical Analysis

The objective of this section is to provide preliminary results on the relation between effective taxes computed in the previous section and some regularities of the business cycle. It also explores how changes in fiscal policy affect directly (through changes in specific tax rates) and indirectly (through yearly updates in income tax brackets, as an example) the estimated path of aggregate tax rates.

6.1 Effective Tax Rates and the Business Cycle

Table 9 summarizes a few basic correlations between average effective tax rates and the business cycle. Most of the significant contemporaneous correlations has the expected sign, especially relating consumption and investment with taxes. In particular, the negative correlation between taxes on consumption, labor income and capital income with the

Table 9: Correlations with Business Cycle

	τ_c	τ_y	τ_l	τ_k
Correlation - Detrended Data				
Output	0.033	0.146	0.035	-0.291*
Consumption	-0.430*	0.215	-0.136	-0.597*
Investment	-0.239	0.195	-0.103	-0.557*
Government Spending	-0.195	0.083	0.062	-0.307*
Correlation - Shares over Output				
Consumption	-0.692*	-0.186	-0.586*	-0.334*
Investment	-0.087	0.127	0.069	-0.030
Government Spending	0.330*	0.478*	0.490*	-0.263*
Trade Balance	0.321*	-0.398*	-0.031	0.560*

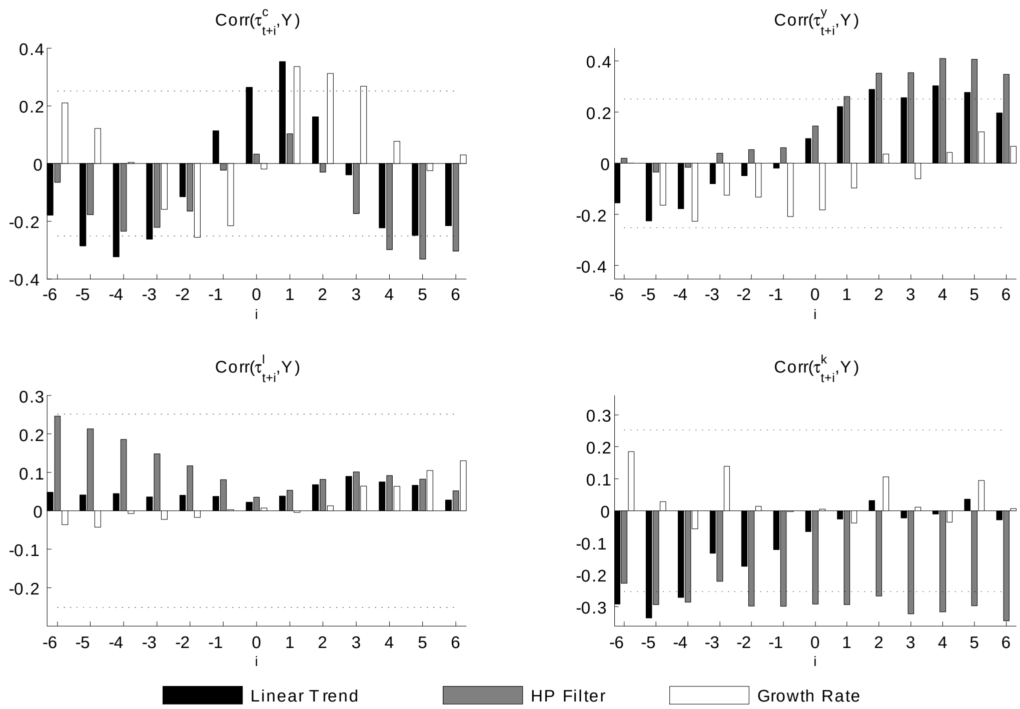
(*) Significant at 5%.

share of consumption suggest a strong substitution between consumption and leisure in the short run, as described in simple RBC models. The correlations of the share of government spending with all tax rates are significant, although it seems counterintuitive that the correlation with the tax on capital income is negative. In terms of robustness, the sign of correlations, if not the significance as well, presented with data filtered by a linear trend are mostly the same if data was HP-filtered.

Figure 7 explores the correlations of effective tax rates in a dynamic framework, associating output detrended by three methods with lagged and future values of effective taxes. First of all, it is worth noting that alternative detrending processes do not alter the general pattern of correlations with output over time, providing, thus, some robustness to results. Second, negative correlations of output with past values of tax rates on consumption and capital income seems to be significant, despite changes in lags conditional on filtering procedure. Third, the recent path of labor income taxes seems to be independent of the business cycle, as most of the correlations with output, both in terms of leads and lags are not significant.

Finally, in order to provide a more formal test on the influence of taxes on the business cycle, table 10 summarizes the results of a set of four VAR models estimated to test Granger-causality between effective tax rates and the business cycles. Each VAR included one of the taxes, plus detrended output, consumption, government spending and investment as endogenous variables, and a dummy that equals one after the first quarter of 2009, in order to control for tax policy changes after the crisis. Due to the large number of variables included, the Schwartz information criteria always selected the inclusion of only one lag in the VAR. Results show the outcome, in terms of p-values, of the causality from taxes to the business cycle (columns 3 and 4) and from the business cycle to taxes

Figure 7: Correlation of Effective Tax Rates and Output



(columns 5 and 6). Columns labeled "sign" show the direction of the causality, simulated from impulse response functions of each VAR.

Results in table 10 show that the impact of taxes on the business cycle points to the expected direction, with an increase in taxes reducing economic activity. Taxes on consumption and individual income were the most related to the business cycles, while labor income taxes didn't show any significant direct impact. On labor taxes, specifically, it is worth noting that its dynamic might be influenced by other factors, not exactly related to economic activity, as described in subsection 6.3. Also, while it would be tempting to discuss fiscal multipliers from the impulse response functions from taxes to the business cycle, it must be recognized that a VAR designed for such task requires a lot more structure than the one adopted here. From a reverse causality perspective, there are very small signs of a relation where the business cycle affects taxes. Only consumption and individual income taxes seems to be affected by output, while the statistical test captures a relationship between government spending and taxes on labor. The sign of causality, derived from impulse response functions, show that an increase in economic activity tends to result in an increase in taxes in the future.

Table 10: Granger-Causality: Taxes and Business Cycle

		Granger-Causality: From Taxes (p-value)	Sign	Granger-Causality: To Taxes (p-value)	Sign
τ_c	Output	0.1123	-	0.0184*	positive
	Consumption	0.0422*	negative	0.2728	-
	Investment	0.2172	-	0.2477	-
	Government	0.0022*	negative	0.8757	-
τ_y	Output	0.0326*	negative	0.0283*	positive
	Consumption	0.2383	-	0.8614	-
	Investment	0.0477*	negative	0.2807	-
	Government	0.0635	-	0.6651	-
τ_l	Output	0.4896	-	0.1078	-
	Consumption	0.5129	-	0.3048	-
	Investment	0.4524	-	0.4418	-
	Government	0.8316	-	0.0164*	positive
τ_k	Output	0.2420	-	0.2463	-
	Consumption	0.1935	-	0.9047	-
	Investment	0.3106	-	0.1451	-
	Government	0.0037*	negative	0.7542	-

6.2 Direct Effects of Tax Policy on Effective Tax Rates

This section relates some important changes in Brazilian tax rates in recent periods with the measurement of effective tax rates proposed here. Table 11 lists thirteen episodes of changes in tax rates, including the creation and the end of taxes and contributions to the tax system. From a chronological perspective, most of the changes in tax rates were done in 2008. That year, in particular, includes changes in policy rates as a response to the financial crisis, but also a significant change in the tax system, early in the year, as a consequence of the end of CPMF. The loss in revenues was partially compensated by the rate increase in other taxes. The thirteen listed episodes also focus on changes in capital income and consumption taxes. It does not include policy changes in labor income or general income taxes because most of the time they did not include movements in tax rates, focusing, instead, on broader issues related to the tax base, like the update of tax brackets.

While the first three columns of table 11 describe the policy change, the fourth column highlights the first period after the change in policy where tax revenues were mostly affected. The fifth and sixth columns provide a measure of impact of the policy change on the economy, showing the change in tax revenues at the first period after the policy change, as a proportion of GDP and the respective tax base. The final two columns compare the change in average tax rate of the specific episode with the change in the aggregate measure of tax rate. As an example, in the first episode presented, setting a tax rate of 0.38% for CPMF represented, in 1999Q3, an increase of revenues of 1.11p.p. of GDP, or almost 3p.p. as a proportion of the tax base of capital rates. Setting a new tax rate for CPMF represented approximately 83% of total variation in capital income tax rates in 1999Q3 ($2.96/3.56 \approx 0.83$).

The first result taken from a general overview of table 11 is that changes in policy tax rates have a good matching to changes in the average effective tax rates, at least on impact. There are only two cases where the change in a specific tax had an opposite sign compared to the change in the aggregate tax rate: the increase in CSLL to financial companies in 2008, when total tax on capital income reduced 0.42% due to the end of CPMF and a reduction in tax rates charged in IRPJ; and the reduction in tax rates of IOF for a few financial operations, when total taxes in consumption increased 0.10%. Excluding those two episodes, changes in policy tax rates were responsible for 79.6% of the change in the effective tax rate for the category. It is also worth noting that the matching seems to be equally good for both large tax changes (in the sense of generating large revenues as a proportion of GDP) and small movements in policy rates.

6.3 Indirect Changes on Effective Tax Rates

This section describes two indirect sources of changes in the measurement of average effective tax rates that are not related to observed variation in tax rate policy: first, this section explores the effects of annual revisions of tax brackets when labor income distribution is changing over time; then, an evaluation of the cyclical behavior of tax revenues provides an idea on the distortions to the measurement of effective tax rates generated by the status of the business cycle. The two exercises, in a sense, complement each other, as they evaluate indirect changes in average effective tax rates from both a cross-sectional – i.e., when the heterogeneity of agents in the economy is one of the main sources of fluctuations – and a time series perspective – especially in the last case, when the state of the economy is the main source of changes in effective tax rates.

In order to analyze the effects of income heterogeneity on the measurement of effective tax rates, consider the case of the update of tax brackets for the annual reports of income taxes. This exercise is particularly important, as Brazil has recently experienced significant real wages increases over time, combined with reduction of labor income inequality. As an example on how updating tax brackets might affect average effective tax rates on labor, consider the case of a household whose income is on the verge of reaching the lower limit of the lowest tax bracket. Assume that the government decides not to update the tax bracket from the previous year. If the household had any extra income gain in the previous fiscal year, she must declare and pay taxes on her total income. That means

Table 11: Impact on Effective Tax Rates of Changes in Policy Rates

Year	Tax Rate	Policy Change	Period	$\frac{\Delta T_i}{GDP}$	$\frac{\Delta T_i}{Tax\ Base}$	$\Delta\left(\frac{T_i}{Tax\ Base}\right)$	$\Delta\tau$
1999	τ^k	CPMF: tax rate = 0.38% (06/1999)	1999Q3	1.11%	2.96%	2.96%	3.56%
2000	τ^k	CPMF: tax rate = 0.30% (06/2000)	2000Q3	-0.22%	-0.63%	-0.85%	-1.10%
2001	τ^k	CPMF: tax rate = 0.38% (03/1999)	2001Q2	0.34%	0.94%	0.97%	2.40%
2002	τ^k	IRPJ: taxes on social security (Provisional Measure 2222, 04/2001)	2002Q1	1.03%	2.67%	2.55%	2.74%
2002	τ^c	Begin CIDE	2002Q1	0.46%	0.84%	0.84%	0.53%
2003	τ^k	CSLL: tax rates = 32% (Law 10.684, 05/2003)	2003Q2	0.27%	0.68%	0.54%	0.89%
2004	τ^c	Cofins: charged over import goods and services (05/2004)	2004Q2	0.76%	1.49%	1.29%	1.53%
2008	τ^k	End CPMF	2008Q1	-0.98%	-2.58%	-2.81%	-4.13%
2008	τ^c	IOF: increase taxes on credit and exchange operations (Decree 6339, 01/2008)	2008Q1	0.34%	0.67%	0.65%	1.54%
2008	τ^k	CSLL: tax rates financial companies = 15% (Provisional Measure 413, 01/2008)	2008Q2	0.36%	0.95%	0.83%	-0.42%
2008	τ^c	CIDE: reduce tax rates on gas prices	2008Q2	-0.07%	-0.13%	-0.15%	-0.11%
2008	τ^c	IOF: reduce taxes on credit and exchange operations (Decrees 6566, 6613, 6655, 6691)	2008Q4	-0.05%	-0.09%	-0.06%	0.10%
2008	τ^c	IPI: reduce tax rates on transport vehicles (Decree 6687, 12/2008)	2009Q1	-0.29%	-0.52%	-0.70%	-4.86%

a larger increase on total tax revenues compared to the change in the tax base, as the household was not paying taxes in the previous year. For the sake of computing average effective tax rates, thus, an update of tax brackets that does not follow changes in real income might generate a procyclical component on the time series.

The overall increase in the number of people paying labor income taxes might justify the upward trend in labor income taxes shown in figure 6. In fact, Orair (2014)[14] relates the increase in tax revenues from IRRF/Labor between 2004 and 2009 in different economic sectors with the increase in formal labor participation in those sectors. From an aggregate perspective, figure 8 shows the share of employed population with labor income at least equal to the lower limit of the lowest tax bracket and the share of employed population earning at least the income defining the highest tax bracket, both as a proportion of total population at least 10 years-old[38]. The figure shows a clear upward trend in the share of employed population earning at least the minimum to pay labor income taxes, from 7% in 2002Q1 to 17.25% in 2014Q4. On the other hand, there is a clear break in 2009 for the number of people paying the highest income tax rate: in that year, the Secretariat of the Federal Revenue created two additional tax brackets, changing the income limit for the highest bracket. The share of employed population charged with income taxes at the highest bracket fluctuated between 2.7 to 4.4% of total population in the sample.

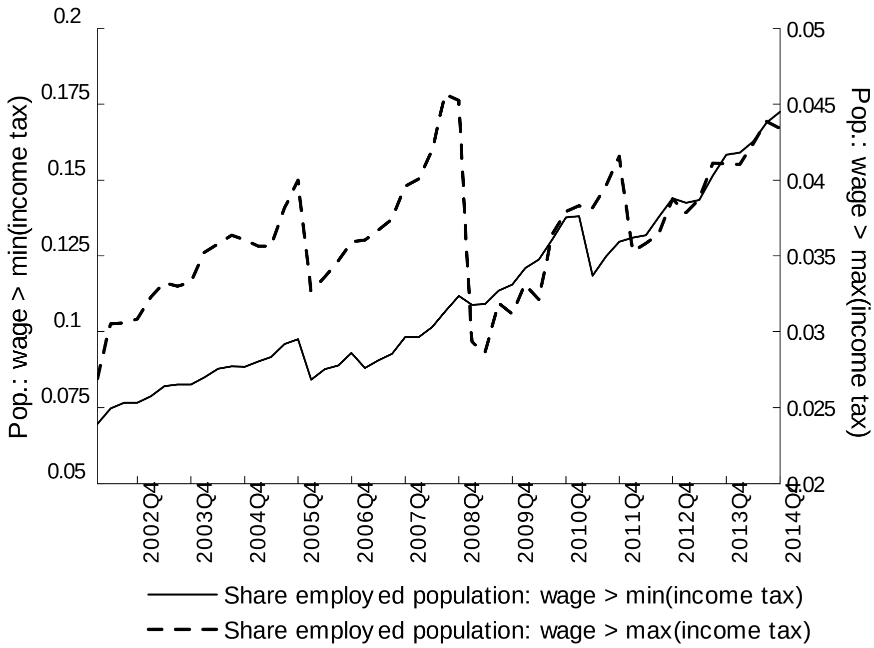
To evaluate the effects of changes in the share of employed population paying labor income taxes, a VAR model is estimated, relating the labor income tax, the two shares described above and the share of population working in the formal sector with respect to total employed population. The numerator is defined as total employed population in the formal, private sector. The 4-variable VAR, estimated with only one lag based on information criteria, also includes as exogenous variable two lags of HP-Filter based output gap and two dummy variables: the first dummy variable equals one after 2006, adjusting for the break in the information set observed after that year; the second dummy variable equals one after 2009, controlling for the change in the number of tax brackets.

Assuming an ordering where the share of employed population in the formal sector is not contemporaneously affected by the other three variables in the system – the "most exogenous variable" in the system – and the labor income tax is contemporaneously affected by all other variables – the "most endogenous variable" – in the Choleski matrix decomposition, figure 9 shows the impulse response functions of the labor income tax after an exogenous shock in the shares of population[39]. Dotted lines show the 95% confidence

[38] The time series show the seasonally adjusted values at the end of each quarter. The time series show only values of PME survey from the new methodology, since the gap between figures on employed population between the old and the new methodology could be a problem in the time series analysis proposed below.

[39] Results are not affected by the Choleski decomposition, as Generalized IRFs generates approximately the same outcome.

Figure 8: Share of Population and Tax Brackets



interval for each impulse response function. Surprisingly, the first graph shows that the increase in population working in the formal sector of the economy is not significant to explain changes in the tax rate. One possible interpretation of this result is that the increase of labor participation in the formal sector was mostly based on low income workers – i.e. those with earnings below the lower limit of the lowest tax bracket. This result is robust to alternative measures of formal labor sector, like the share of employed population with valid work documentation, or the share of employed population in the private formal sector as a proportion of total workers in the private sector. The measurement of labor income taxes also does not significantly changes with an increase in the share of population with income at least equal to the highest bracket. On the other hand, labor income taxes show significant increase with changes in the share of population with income above the minimum established in the lowest bracket. In this case, reported in the third graphic of the figure, an increase of 1p.p. in the share of population declaring income at least equal to the minimum established in the lowest bracket results in larger and persistent impact in the measurement of labor taxes, with an increase of 0.4p.p. after 6 to 8 quarters.

Another way to evaluate indirect sources of fluctuations in tax rates is to relate tax revenues with economic activity at the business cycle frequency. If the tax base and tax revenues are perfectly correlated, any observed cyclical behavior of average effective tax rates must be a consequence of tax policy and not a by-product of economic fluctuations.

Figure 9: Impulse Response Functions of Labor Income Taxes – VAR(1) Model

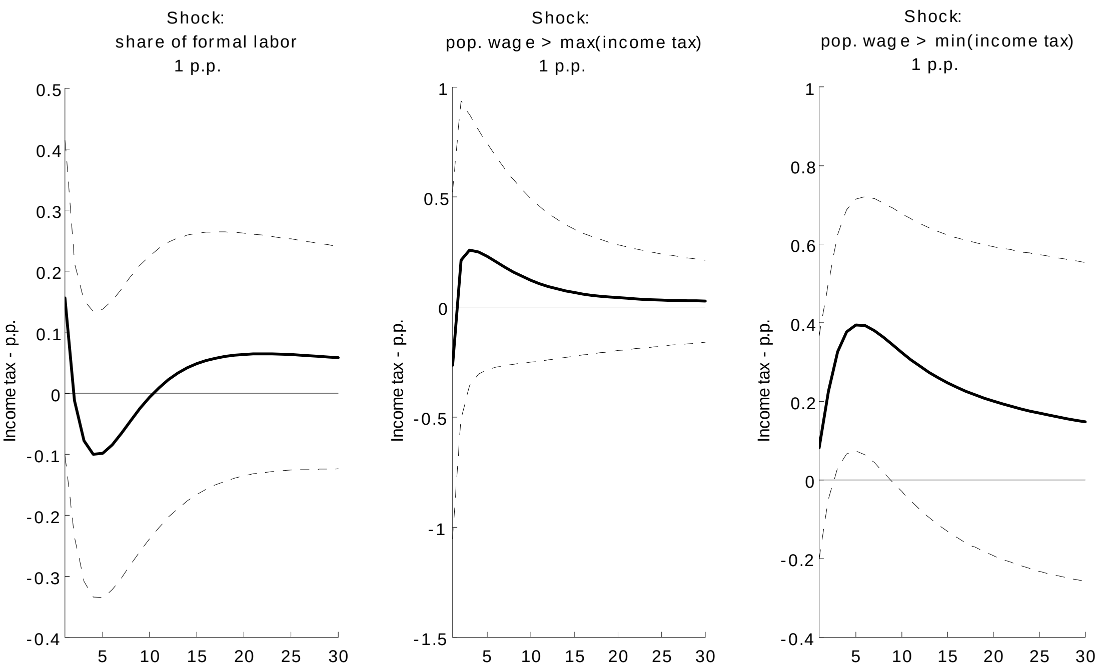


Table 12 shows the sample correlation of tax revenues with fluctuations of tax base, output and consumption. All variables are measured in real terms, using the Extended National Consumer Price Index (IPCA) as a deflator, seasonally adjusted and the log is filtered by a linear trend. In the sample, revenues of income and labor taxes move together with fluctuations of their own tax base, as shown in the first line of results of table 12. Labor income and individual income tax revenues show significant positive correlation with output and consumption fluctuations, while the revenues of capital income taxes are markedly countercyclical. Consumption tax revenues do not present a significant correlation with their own tax base at the business cycle frequency. However, the strong correlation with output and consumption suggests that the lack of significant correlation between revenues and the tax base is a consequence of adding other components of the tax base. More specifically, the correlation between revenues from consumption taxes and the sum of household and government consumption (0.35) is still positive and significant in the sample, suggesting that the spending in government employee's wages is responsible for breaking the significance of correlation.

Table 12: Correlation - Tax Revenues with Tax Base and Business Cycle

	Tax Revenues			
	Consumption	Labor Income	Capital Income	Individual Income
Tax Base	0.11	0.76*	0.20	0.61*
Consumption	0.39*	0.74*	-0.60*	0.63*
Output	0.60*	0.85*	-0.30*	0.62*

(*) Significant at 5%.

7 Conclusions

This paper estimated time series of effective tax rates for consumption and factor incomes for Brazil, following the methodology of Mendoza et al (1994)[12] and Lledó (2005)[10], using a large number of databases in order to acquire information on tax revenues and tax base at quarterly frequency. The procedure to generate quarterly approximations seems to be effective, despite its simplicity, as the yearly approximations of the quarterly estimates remained very close to the actual annual datasets usually used to perform such estimates. The time series of the tax burden and the effective tax rates also seem to be in line with the historical Brazilian experience on fiscal policy. The estimated tax burden correctly identifies a positive trend over time, despite the partial interruption after the international crisis in 2008.

A good question after the exercise of computing such effective tax rates is the capacity of the dataset presented here to be regularly updated, in order to provide timely analysis for policy actions. One natural problem of working with data from SISTN and FINBRA is the long time it takes the municipalities to send reports and the system administrator to make them available. The National Treasury usually makes the files available in the last quarter of the following year. For a real time application of this dataset, it would be necessary to use alternative sources to collect data at the subnational government's level, or use auxiliary models estimated to provide short run forecasts of tax revenues.

Even with these difficulties, this dataset can be useful for various fiscal policy analysis exercises. For example, one can use the tax rates series for the estimation of fiscal rules or, for a more accurate calibration or estimation of general equilibrium models aimed at studing the effects of fiscal measures. These remain as suggestions for future research.

References

[1] C. H. Araújo and P. C. Ferreira. Reforma tributária, efeitos alocativos e impactos de bem-estar. *Revista Brasileira de Economia*, 53(2):133–166, 1999.

[2] V. B. Araújo Neto and M. C. S. Sousa. Tributação da renda e do consumo no brasil: Uma abordagem macroeconômica. *Proceedings of the 29th Brazilian Economics Meeting from ANPEC*, 2001.

[3] D. Carey and J. Rabesona. Tax ratios on labour and capital income and on consumption. *OECD Economic Studies*, (35), 2002.

[4] F. A. Carvalho and M. Valli. Fiscal policy in brazil through the lens of an estimated DSGE model. Working Papers Series 240, Central Bank of Brazil, Research Department, 2011.

[5] M. A. F. H. Cavalcanti and N. L. C. Silva. Impactos de políticas de desoneração do setor produtivo: Uma avaliação a partir de um modelo de gerações superpostas. *Estudos Econômicos*, 40(4):943–966, 2010.

[6] C. M. Considera and S. A. Pessoa. A distribuição funcional da renda no Brasil: 1959-2008. Textos para Discussão 277, Universidade Federal Fluminense - Faculdade de Economia, 2011.

[7] P. C. Ferreira and R. A. C. Pereira. Avaliação dos impacto macroeconômicos e de bem-estar da reforma tributária no brasil. *Revista Brasileira de Economia*, 64(2):149–175, 2010.

[8] V. Gomes, M. N. S. Bugarin, and R. G. Ellery Jr. Long-run implications of the Brazilian capital stock and income estimates. *Brazilian Review of Econometrics*, 25(1):67–88, May 2005.

[9] IBGE. Sistema de Contas Nacionais - Brasil. Technical report, Instituto Brasileiro de Geografia e Estatística - IBGE, 2008.

[10] V. D. Lledó. Tax system under fiscal adjustment: A dynamic CGE analysis of the Brazilian tax reform. IMF Working Paper 05/142, International Monetary Fund, 2005.

[11] M. Medeiros, P. H. G. F. Souza, and F. A. Castro. O topo da distribuição de renda no Brasil: Primeiras estimativas com dados tributários e comparação com pesquisas domiciliares, 2006-2012. Working paper, 2014.

[12] E. G. Mendoza, A. Razin, and L. L. Tesar. Effective tax rates in macroeconomics cross-country estimates of tax rates on factor incomes and consumption. *Journal of Monetary Economics*, 34:297–323, 1994.

[13] J. R. B. Nogueira, R. B. Siqueira, P. J. Santana, H. Levy, and E. S. Souza. A carga tributária efetiva sobre o trabalho no Brasil: Nível, distribuição e composição. *Análise Econômica*, 31(59), Apr. 2013.

[14] R. O. Orair. A dinâmica recente da carga tributária no Brasil: o que explica o paradoxo do crescimento da carga tributária em meio a seguidas desonerações tributárias? in: Finanças públicas e macroeconomia no Brasil: um registro da reflexão do Ipea (2008 - 2014) volume 2, Instituto de Pesquisa Econômica Aplicada, 2014.

[15] R. O. Orair, S. W. Gobetti, E. M. Leal, and W. d. J. Silva. Carga tributária brasileira: Estimação e análise dos determinantes da evolução recente - 2002-2012. IPEA Texto para Discussão 1875, Instituto de Pesquisa Econômica Aplicada, 2013.

[16] F. M. Pereira. *Modelos de Ciclos Reais de Negócios com Imposto e Setor Externo: O Caso Brasileiro.* PhD thesis, Departamento de Economia - Universidade de Brasília, 2009.

[17] R. B. Siqueira, J. R. Nogueira, and E. S. Souza. A incidência final dos impostos indiretos no Brasil: Efeitos da tributação de insumos. *Revista Brasileira de Economia*, 55(4):513–544, Sept. 2001.

[18] B. Volkerink, J.-E. Sturm, and J. de Haan. Tax ratios in macroeconomics: Do taxes really matter? *Empirica*, 29(3):209–224, 2002.

A Annual time series of distortionary taxes: 1999-2009

	Consumption	Income	Labor	Capital	General Income
1999	21.06	0.94	18.41	14.33	17.76
2000	23.58	0.94	19.11	15.42	18.59
2001	24.65	0.98	19.59	16.19	19.23
2002	25.37	1.02	20.02	19.14	20.68
2003	24.30	0.92	20.48	17.90	20.34
2004	26.84	0.91	21.64	17.24	20.69
2005	26.15	0.95	22.20	18.98	21.81
2006	25.40	1.00	22.49	19.07	22.09
2007	25.99	1.13	22.18	20.67	22.70
2008	28.00	1.16	22.51	18.15	21.94
2009	24.25	1.12	22.40	17.26	21.51

B Quarterly time series of distortionary taxes: 1999Q1-2014Q4

	Consumption	Income	Labor	Capital	General Income
1999Q1	17.54	0.98	18.90	13.30	17.30
1999Q2	19.36	0.88	18.45	10.06	15.48
1999Q3	20.25	0.95	18.57	13.55	17.39
1999Q4	20.12	0.92	18.43	13.43	17.07
2000Q1	23.71	0.92	18.51	15.54	18.20
2000Q2	22.27	0.97	18.35	14.79	17.70
2000Q3	23.07	0.92	18.07	13.99	17.43
2000Q4	23.96	0.92	18.53	15.04	17.98
2001Q1	24.33	0.93	18.96	13.62	17.43
2001Q2	25.30	1.01	19.52	15.90	18.85
2001Q3	24.83	1.02	19.28	15.60	18.85
2001Q4	23.35	0.95	20.43	14.86	18.86
2002Q1	24.27	1.10	19.38	17.42	19.75
2002Q2	24.46	0.89	18.98	16.48	18.56
2002Q3	26.37	1.07	19.35	19.30	20.47
2002Q4	26.92	1.07	19.28	18.54	19.91
2003Q1	25.04	1.06	19.57	16.06	19.06
2003Q2	23.88	0.88	20.05	16.97	19.28
2003Q3	23.47	0.84	20.67	14.74	18.64
2003Q4	25.74	0.94	21.54	16.10	19.82
2004Q1	26.52	0.93	21.43	16.14	19.87
2004Q2	28.13	0.91	21.62	14.78	19.14
2004Q3	27.53	0.86	21.28	15.93	19.60
2004Q4	26.70	0.91	21.65	15.42	19.57
2005Q1	27.60	0.90	22.02	16.55	20.37
2005Q2	27.40	0.99	22.36	17.29	20.85
2005Q3	26.93	1.02	22.43	16.75	20.71
2005Q4	26.36	0.86	22.57	17.78	20.99

	Consumption	Income	Labor	Capital	General Income
2006Q1	26.50	0.90	23.49	16.40	21.02
2006Q2	26.22	1.04	23.71	18.29	22.22
2006Q3	26.20	1.02	24.03	17.07	21.72
2006Q4	26.34	0.98	23.96	16.05	21.14
2007Q1	25.85	1.06	23.45	16.57	21.27
2007Q2	25.92	1.09	24.07	17.44	21.98
2007Q3	26.89	1.14	24.53	17.79	22.41
2007Q4	26.87	1.26	23.79	19.86	22.96
2008Q1	28.55	1.20	24.41	16.33	21.83
2008Q2	28.33	1.10	23.87	15.79	21.25
2008Q3	28.62	1.16	23.80	16.41	21.57
2008Q4	28.41	1.17	23.44	15.99	21.29
2009Q1	24.11	1.23	23.72	16.43	21.68
2009Q2	23.79	1.02	23.87	15.07	20.96
2009Q3	23.94	1.12	23.46	14.01	20.32
2009Q4	26.24	1.14	24.27	14.67	20.85
2010Q1	26.21	0.98	24.05	13.32	19.97
2010Q2	26.79	1.09	24.11	13.69	20.40
2010Q3	26.58	1.02	23.97	13.91	20.37
2010Q4	26.44	1.08	24.82	13.53	20.67
2011Q1	28.55	1.16	24.99	14.05	20.97
2011Q2	26.42	1.15	24.70	14.14	20.82
2011Q3	27.49	1.15	25.10	16.16	22.02
2011Q4	26.89	1.11	24.80	14.44	21.17
2012Q1	26.69	1.12	24.94	15.31	21.75
2012Q2	26.50	1.19	24.67	14.66	21.42
2012Q3	25.65	1.17	24.38	14.31	21.17
2012Q4	25.60	1.19	24.03	14.82	21.32
2013Q1	26.14	1.17	24.48	15.31	21.62
2013Q2	26.36	1.20	25.49	14.38	21.63
2013Q3	26.42	1.20	25.24	14.33	21.62
2013Q4	26.09	1.25	25.35	14.73	21.84
2014Q1	25.77	1.25	25.23	14.33	21.54
2014Q2	27.53	1.21	25.33	15.90	22.44
2014Q3	24.16	1.24	25.23	15.23	22.12
2014Q4	27.79	1.13	25.09	15.13	22.03

C Description of Taxes and Contributions

Here we give a short description of the taxes and contributions used in this study, including their names in Portuguese[40]. They are broken down by jurisdiction (Federal, State or Municipal). Although long, this list does not include all the taxes and contributions levied in Brazil, but the ones there were classified in one of the categories used in this study.

C.1 Federal Government Taxes

Cide - Contribuição sobre Intervenção no Domínio Econômico (Contribution of Intervention in the Economic Domain) - Tax levied on some specific products, the main one being fuel.

CSLL - Contribuição Social sobre o Lucro Líquido (Social Contribution on Net Profit) - Contribution levied on profit before income tax destined to finance the social security system.

Cofins - Contribuição para o Financiamento da Seguridade Social (Contribution for the Financing of the Social Security) - Contribution charged monthly on the gross revenue from the sale of goods and services destined to finance the social security system.

CPMF - Contribuição Provisória sobre Movimentação ou Transmissão de Valores e de Créditos e Direitos de Natureza Financeira (Provisional Contribution on Financial Movement) - Contribution levied on bank debits of individuals or corporations.

CPSS/Federal - Contribuição para o Plano de Seguridade Social do Servidor - Federal (Civil Servants' Social Security Contribution - Union) - Contribution on the earnings of federal civil servants to finance their social security system.

FGTS - Fundo de Garantia por Tempo de Serviço (Employee Indemnity Guarantee Fund) - Contribution levied on the payroll of corporations or individuals (household employers).

II - Imposto sobre Importação (Import Tax) - Import duty applied to the entrance of foreign products.

IOF - Imposto sobre Operações Financeiras (Tax on Financial Operations) - Tax levied on financial operations and assessed on different types of events, such as credit, foreign exchange, securities and insurance.

IPI - Imposto sobre Produtos Industrializados (Tax on Industrialized Products) -

[40] Sources:
http://www2.apexbrasil.com.br/en/invest-in-brazil/how-to-invest-in-brazil/tax-system
http://thebrazilbusiness.com/tax
http://www.receita.fazenda.gov.br/principal/Ingles/SistemaTributarioBR/Taxes.htm

Value Added Tax paid by manufactures on behalf of their customers at the time of sale. It is considered on the sale cost and transferred to the buyer.

IRPF - Imposto sobre a Renda da Pessoa Física (Individual Income Tax) - Tax levied on individuals´ salaries and earnings.

IRPJ - Imposto de Renda de Pessoas Jurídicas (Corporate Income Tax) - Corporate revenue tax applied to the net profits of any legal entity.

IRRF/Capital - Imposto de Renda Retido na Fonte - rendimento do capital (Withholding Income Tax - Capital Income) - Tax levied on gross income on capital such as equity, investments, stocks for individuals and corporations.

IRRF/Trabalho - Imposto de Renda Retido na Fonte - rendimento do trabalho (Withholding Income Tax - Labor Income) - Tax levied on salaries and earnings withheld by the payer.

IRRF/Remessas - Imposto de Renda Retido na Fonte - rendimento de remessa p/ ext. (Withholding Income Tax - Income from remittances abroad) - Tax levied on profits, dividends, interest and amortization, royalties, technical, scientific, administrative or similar assistance, remitted abroad by individuals and corporations.

IRRF/Outros - Imposto de Renda Retido na Fonte - outros rendimentos (Withholding Income Tax - Others) - Tax on prizes and drawings, advertisement services, payment of professional services, among others.

ITR - Imposto Territorial Rural (Tax on Rural Land Property) - Tax on the value of rural property owned by individuals or corporations.

PASEP - Programa de Formação do Patrimônio do Servidor Público (Civil Servants' Savings Program Contribution) - Contribution analogous to PIS, but applied to civil servants.

PIS - Programa de Integração Social (Contribution to the Social Integration Program) - Contribution destined to finance the payment of insurance, unemployment allowance and participation in revenues from agencies and entities for public and private workers.

RGPS - Contribuição para o Regime Geral de Previdência Social (Contribution to the General Social Security System) - Contribution on payroll and self-employment earnings.

SE - Salário Educação (Education Wage) - Social contribution intended to finance projects, programs and actions oriented to public basic education.

Sistema "S" - Contribuições para o Sistema S (Contributions to the "S" System) - Joint system of social contributions paid by companies in order to finance the Autonomous Social Services (The so called "S" system is composed by the following bodies: SENAR (National Rural Training Service), SENAI (National Industrial Training Service), SESI (Social Service of Industry), SENAC (National Commercial Training Service), SESC (Social Service of Commerce), SESCOOP (National Service of Cooperativism Apprenticeship), SEST (Social Service of the Transport Sector), SENAT (National Transportation Training Service), SEBRAE (Brazilian Service of Micro and Small Size Companies Support), IEL (Euvaldo Lodi Institute), Aviation Fund and maritime Professional Education).

C.2 State Government Taxes

CPSS/States - Contribuição para o Plano de Seguridade Social do Servidor - Estados (Civil Servants' Social Security Contribution - States) - Contribution on the earnings of state civil servants to finance their social security system.

ICMS - Imposto sobre a Circulação de Mercadorias e Serviços (Tax on the Circulation of Goods and Transportation and Communication Services) -Value Added Tax on Circulation of Goods and Interstate and Intercity Transportation and Communication Services.

IPVA - Imposto sobre a Propriedade de Veículos Automotores (Tax on Motor Vehicles) - Tax charged over the property of motorized any vehicles.

ITCD - Imposto sobre Transmissão Causa Mortis e Doação (Tax on inheritance and Gifts) - Tax payable by every person or legal entity that receives goods and rights such as inheritance or donation.

C.3 Municipal Government Taxes

CPSS/Municipal - Contribuição para o Plano de Seguridade Social do Servidor - Municípios (Civil Servants' Social Security Contribution - Municipalities) Contribution on the earnings of municipal civil servants to finance their social security system.

IPTU - Imposto Predial e Territorial Urbano (Tax on Urban Land and Property) Tax levied on the property of urban real estate.

ISS - Imposto Sobre Serviços de Qualquer natureza (Tax on Services of any kind) - Tax applied to the services provided to a third party by a company or professional and is paid by the service provider. Includes services not covered by ICMS.

ITBI - Imposto sobre a Transmissão de Bens Imóveis Inter-Vivos (Tax on Real Estate Conveyance) - Tax on the onerous transfer of immovable property or rights related to it.

D Adjustment of Data from SISTN

In order to adjust the SISTN database for the differences from the data on FINBRA, we use the monthly data of each tax revenue from SISTN, labeled $SISTN\_X_{I,J,K}$, where $X \in \{IPTU, ISS, ITBI\}$, for each municipality and the Federal District $I \in \{1, ..., 5569\}$, in each month $J \in \{1, ...12\}$ of each year $K \in \{2006, ..., 2014\}$. The first step of the adjustment was to compute the individual average share for each month's revenue over the total revenue of the year. For instance, the individual average share for tax X in January, for municipality I, is given by:

$$Share\_X_{I,Jan} = \frac{\sum_{K=2006}^{2014} SISTN\_X_{I,Jan,K}}{\sum_{K=2006}^{2014} \sum_{J=1}^{12} SISTN\_X_{I,J,K}} \tag{14}$$

The individual average share was computed for each municipality in each month, using only those municipalities with information for all the 12 months in a given year.

We also compute an aggregate average share for all municipalities, which will be used to distribute the data of those municipalities that have data on FINBRA, but do not have enough monthly data to compute its own share. So, for example, the aggregate average share for January is given by:

$$Share\_X_{Avg,Jan} = \frac{\sum_{I=1}^{5569} \sum_{K=2006}^{2014} SISTN\_X_{I,Jan,K}}{\sum_{I=1}^{5569} \sum_{K=2006}^{2014} \sum_{J=1}^{12} SISTN\_X_{I,J,K}} \tag{15}$$

Equation 15 provides an aggregate average share of tax collection for each month. For the observations of the municipalities for which there is data available both on SISTN and on FINBRA, we obtain an adjusted tax revenue $X_{I,J,K}$ distributing the difference between the annual data from FINBRA ($FINBRA\_X_{I,K}$) and the 12-month accumulated data from SISTN $\left(\sum_{J=1}^{12} SISTN\_X_{I,J,K} \right)$. For those municipalities that we were able to compute the individual average share:

$$X_{I,J,K} = SISTN\_X_{I,J,K} + Share\_X_{I,J} \times \left(FINBRA\_X_{I,K} - \sum_{J=1}^{12} SISTN\_X_{I,J,K} \right) \tag{16}$$

In a case where, in a given year, information is missing from SISTN for a given municipality, but there is data from FINBRA, if we were able to compute the individual average share for that municipality, just distribute the annual observation from FINBRA according to the respective shares:

$$X_{I,J,K} = Share\_X_{I,J} \times FINBRA\_X_{I,K} \tag{17}$$

For the case where it was not possible to get an individual average share for that municipality, use the aggregate average share to distribute annual data from FINBRA:

$$X_{I,J,K} = Share\_X_{Avg,J} \times FINBRA\_X_{I,K} \tag{18}$$

Finally, in a last case, if information on taxes is not available on FINBRA for a given municipality in a given year, but there is data on SISTN, observation in SISTN is kept in the adjusted database. The gap observed in table 4 between the FINBRA row and the adjusted values for each tax is a consequence of keeping the SISTN observation for municipalities where information from FINBRA was missing.

The computed individual and aggregate shares of revenues were also used to build an extended quarterly dataset, incorporating information for the period between 1999 and 2005. In order to compute a monthly approximation of tax collection, latter aggregated for quarterly frequency, we used annual information available on FINBRA and distributed that value in each year, for every municipality, according to the shares computed in equations 17 and 18. Thus, for the period 1999-2005, 12-month accumulated tax collection from the approximation built using the shares matches exactly the annual value provided by FINBRA.

With this procedure we end up with a monthly series that runs from January/1995 to December/2014 for the three municipal taxes, that was later converted into quarterly series. We also use this procedure to adjust the payroll and social charges data for states and municipalities at bimonthly frequency from SISTN with the annual data from FINBRA (for municipalities) and from the National Treasury Secretariat in the Report of Budget Execution of the States. The restriction of using only bimonthly data required an additional simplification hypothesis in order to build a quarterly time series. We assumed that the value of government employees' compensations in bimesters containing information for months from different quarters ($B2 = March + April$ and $B5 = September + October$) is equally split in each month. Thus we split information for the second (fifth) bimester putting half in the first (third) quarter and half in the second (fourth) quarter. The figure below illustrates the procedure:

<table>
<tr><td colspan="3">$Q1$</td><td colspan="3">$Q2$</td><td colspan="3">$Q3$</td><td colspan="3">$Q4$</td></tr>
<tr><td colspan="2">$B1$</td><td colspan="2">$B2$</td><td colspan="2">$B3$</td><td colspan="2">$B4$</td><td colspan="2">$B5$</td><td colspan="2">$B6$</td></tr>
<tr><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
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$\Downarrow$

$Q_1 =$	$Q_3 =$	$Q_3 =$	$Q_4 =$
$B1 + (1/2) \times B2$	$(1/2) \times B2 + B3$	$B4 + (1/2) \times B5$	$(1/2) \times B5 + B6$