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The effect of allocation function in budgeting to reduce income inequality in Brazil: an analysis of spending on education and health from 1995 to 2012

Giovanni Pacelli Carvalho Lustosa da Costa
Universidade de Brasília / Programa de Pós-Graduação em Ciências Contábeis
Brasília / DF — Brazil

Ivan Ricardo Gartner
Universidade de Brasília / Programa de Pós-Graduação em Administração
Brasília / DF — Brazil

Income inequality is seen as a major problem of contemporary society. In order to reverse inequality the state can use allocation function in budgeting. This study sought to identify the impacts of allocation function in budgeting on income inequality for Brazilian states from 1995 to 2012. Spending on education and health was considered as an allocative function proxy, while the Gini coefficient, the Theil coefficient, was used as a proxy for income inequality. This found the ratio between the richest 10% and the poorest 40%, and the ratio between the richest 20% and poorest 20%. The functional relationship between the two sets of variables was explored in the analysis of panel data and tobit regression. Considering aggregate expenditure on education and health of states and municipalities in the period, it was concluded that federative units that invested more in health have been better at reducing income inequality, with the opposite effect occurring for the cost of education. When spending on health and education are broken down into several sections, it can be seen that the federation units with higher volume of spending in the following sub-functions (2nd level of function) — Primary health care, hospital and outpatient care, prophylactic and therapeutic support and early childhood education — have made greater gains in reducing income inequality.

Keywords: regional economy; income inequality; Allocation function in budgeting; public spending on education and health.

O efeito da função orçamentária alocativa na redução da desigualdade de renda no Brasil: uma análise dos gastos em educação e saúde no período de 1995 a 2012

A desigualdade de renda é apontada como um dos grandes problemas da sociedade atual. A fim de reverter o cenário desigual, o Estado pode atuar utilizando a função orçamentária alocativa. Este estudo buscou identificar os impactos da função alocativa do orçamento sobre a desigualdade de renda, para as unidades federativas brasileiras no período de 1995 a 2012. Foram considerados como proxy da função alocativa os gastos com educação e saúde, enquanto foram utilizados como proxy da desigualdade de renda o coeficiente de Gini, o coeficiente de Theil, a proporção entre os 10% mais ricos e os 40% mais pobres, e a proporção entre os 20% mais ricos e os 20% mais pobres. A relação funcional entre os dois conjuntos de variáveis foi explorada a partir da análise de dados em painel e da regressão tobit em painel. Considerando-se os gastos agregados em educação e saúde de estados e municípios no período, concluiu-se que as unidades da federação que investiram mais em saúde conseguiram reduzir as desigualdades de renda com maior intensidade, ocorrendo efeito oposto com as despesas com ensino. Quando os gastos em saúde e ensino foram desagregados em várias rubricas, concluiu-se que as unidades da federação com maior volume de gastos nas seguintes subfunções (2º **nível da função):** atenção básica, assistência hospitalar, suporte profilático e ambulatorial, e educação infantil conseguiram reduzir as desigualdades de renda com maior intensidade.

Palavras-chave: economia regional; desigualdade de renda; função orçamentária alocativa; gastos públicos com educação e saúde.

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El efecto de la función asignativa en la reducción de la desigualdad de ingresos en Brasil: un análisis del gasto en educación y salud 1995-2012

La desigualdad de ingresos se ve como un problema importante de la sociedad contemporánea. Con el fin de revertir la situación desigual, el Estado puede actuar mediante la función asignativa de presupuesto. Este estudio trata de identificar los impactos de la función de la asignación de recursos del presupuesto en la desigualdad de ingresos para los estados de Brasil 1995 a 2012. Fueron considerados como un indicador de la función asignativa el gasto en educación y salud, mientras que se utilizaron como apoderado la desigualdad de ingresos el coeficiente de Gini, el coeficiente de Theil, la relación entre el 10% más rico y el 40% más pobre, y la relación entre el 20% más rico y el 20% más pobre. La relación funcional entre los dos conjuntos de variables se exploró a partir del análisis de datos de panel y el panel de regresión Tobit. Teniendo en cuenta los gastos agregados sobre la educación y la salud de los estados y municipios en el período, se concluyó que las Unidades de la Federación que han invertido más en salud han logrado reducir la desigualdad de ingresos con mayor intensidad, que se producen efecto contrario con el costo de la educación. Cuando el gasto en salud y educación ha sido dividido en varias secciones, se concluyó que las unidades de la federación con mayor volumen de gasto en la siguientes subfunciones (segundo nivel de función): atención primaria, atención hospitalaria, asistencia preventiva y la atención ambulatoria, y educación de la primera infancia han logrado reducir la desigualdad de ingresos con mayor intensidad.

Palabras clave: economía regional; la desigualdad de ingresos; presupuesto función asignativa; el gasto público en educación y salud.

1. INTRODUCTION

The excessive income and wealth concentration separating social classes and increasing inequalities is one of the central problems of modern capitalism according to the Keynesian school of thought. This imbalance hinders the maintenance of full employment in modern economies, because the small population of rich, who benefit from the income and wealth concentration, consume a smaller part of the total consumer goods when compared to what is consumed by the mass of poor population. The result is a weaker demand for consumer goods, which discourages its production and, indirectly, of capital goods. In addition, the excessive concentration of wealth jeopardizes the legitimacy of capitalism itself, because it creates social groups that enjoy social wealth without having contributed to its production (Keynes, 1996; Carvalho, 2008). The solution for this problem based on Keynesianism (adopted most often by economists) lays mainly in the promotion of institutional changes, such as the introduction of progressive taxes and capital gain taxes (especially on inheritance). The economic policy could help, but it would not be particularly strong to this end (Keynes, 1996; Carvalho, 2008).

Recently, in September 2000, 189 nations signed a pledge to fight extreme poverty and other issues in society. This promise was expressed by the 8 Millennium Development Goals (MDGs) that were to be achieved by 2015 (Millennium Development Goals, 2014). In September 2010, the world renewed its commitment to accelerate progress towards meeting these goals.

At the end of 2014, the United Nations (UN, 2000) reported that between 2000 and 2010 Brazil had reduced the income inequality among metropolitan regions, and between the North and the South of the country. The difference between São Paulo, with the highest Municipal Human Development Index (MHDI), and Manaus, the lowest MHDI, was 22.1% in 2000. Ten years later, this percentage fell by half to 10.3%. One of the positive results is that none of the municipalities

showed a very low development. On the other hand, the results show that inequalities persist within the metropolitan regions, even with the extraordinary progress made (Millennium Development Goals, 2014).

Regarding this negative result pointed out in the UN's report, Paes and Siqueira (2008) had already warned that one of the great paradoxes of the present time is the coexistence of extremely developed economies amid enormous pockets of poverty. This happens both between countries on the same continent and between regions of the same country. The distribution of *per capita* income in rich developed economies and in pockets of poverty seems to exhibit a persistent pattern: the two extremes seem to diverge from each other. The rich becoming richer and the poor becoming poorer.

As for the discussion on possible solutions to fight excessive income and wealth concentration, Musgrave and Musgrave (1980) proposed three economic functions of the modern budget: distribution, which aims to adjust income distribution and the offer of goods and services to the population in need; allocation, which aims to adjust allocation of resources; and the stabilization function, which aims to maintain economic stability.

Contemporary studies on inequality have as one of its references the work of Simon Kuznets: *Economic growth and income inequality* (1955). Kuznets (1955) used a dual model with an agricultural and a non-agricultural sector — modern and dynamic — in order to analyze the relationship between income inequality and economic growth. The author's findings indicate that income inequality would rise in the short term and, with economic growth, inequality would reduce forming an inverted U. Thus, it was assumed that countries with a low degree of development would tend to present a higher level of income inequality in the short term and that this relationship would tend to revert as these countries work their way to achieve higher levels of *per capita* income.

Considering the conclusions of the Kuznets study, which focuses on the stabilization function related to economic growth, this work focuses only on the allocation and its relations with income inequality, the phenomenon that increases social problems.

Although they have not been organized in this way, previous works have used elements of the allocation function as independent variables.

Studies by Meltzer and Richard (1983), Perotti (1992), Easterly and Rebelo (1993), Lindert (1996), Perotti (1996), Partridge (1997), Gouveia and Masia (1998), Bassett, Burkett and Putterman (1999), Rodriguez (1999), Tanninen (1999), Castronova (2001), Jha, Biswal and Biswal (2001), Panizza (2002), Sylwester (2002), Mello and Tiongson (2006), Bergh and Fink (2008), Zhang (2008) and Holzner (2010) use public spending and elements of the allocation function in budgeting, as an attempt to evaluate their respective impact on reducing income inequality.

An important factor in the research would be the variable used to measure inequality. The work of Easterly and Rabelo (1993), Figini (1998), Tanninen (1999), Sylwester (2002), Mello and Tiongson (2006), Bergh and Fink (2008), Zhang (2008) and Holzner (2010) used Gini coefficient. The difference between the mean and median rates of income was used in the studies of Meltzer and Richard (1983) and Gouveia and Masia (1998). In the studies of Perotti (1992), Persson and Tabellini (1994), Perotti (1996), Partridge (1997), Bassett, Burkett and Putterman (1999), Panizza (2002) the Q3 was used (Q3 being the proportion of the income of the 3rd quintile of the population: higher the proportion, lower

the inequality). Studies by Jha, Biswal and Biswal (2001) and Lima, Moreira and Souza (2013) used poverty indicators. The variation in the income index was used in the study by Lindert (1996). The asymmetric distribution was used in the study by Rodriguez (1999). Finally the *per capita* income, was used in the study by Castronova (2001).

Considering this context, the research question is: *what is the effect of education and health spending on reducing income inequality in the Brazilian States between 1995 and 2012?*

Therefore, this study aims to evaluate the reduction of income inequalities in Brazilian States from the fiscal variables that are representative of the allocation function: spending on health and education.

This article is divided into five sections. After this introduction, section 2 presents a review of the literature on income inequality and the economic functions of the budget. Section 3 presents aspects of the methodology adopted in this research such as the description of the variables and the econometric models used. Section 4 describes and analyzes the empirical results concerning the impact in terms of elasticity coefficients of factors that contribute to the reduction of income inequality using panel data analysis and the regression analysis tobit model with panel data. Finally, section 5 presents the conclusions of the study.

2. THEORETICAL FRAMEWORK

2.1 PERCEPTIONS OF INEQUALITY

Inequality is not a natural fact, but a social construction. It depends on circumstances and is largely the result of political choices made throughout the history of each society. All societies experience inequalities and they are presented in many different ways such as prestige, power, income. The origins of inequalities are as varied as the way they are expressed. The challenge is not only to describe the factors and elements of social inequalities, but also to explain how and why they remain or even increase in society, despite the modern values that push for equality (Scalon, 2011).

In this sense, the perception of inequality is relative when it comes to the objects of the analysis. Hypothetically, if an entire population lives in poverty and at the same level of poverty, then there is no inequality, but there is poverty. On the other hand, if rich people as well as very rich people form the population of a country, then there is no poverty but there is inequality. Therefore, poverty can be reduced without changing the inequality.

According to Cowell (2011), equality or inequality can be interpreted in different ways, which are described in Figure 1.

As for the perspectives presented in figure 1, horizontal equity means to treat equals equally. The social minimum is to ensure that everyone has a minimum standard of wellbeing. The equality of lifelong income profiles focuses on reducing inequality in prospective future income. Mobility aims to reduce barriers between occupational groups allowing for social accession. Inclusive economy aims to reduce or eliminate the feeling of exclusion from society caused by differences in income or other factors. Initiatives for income generation aim to increase the share of national income received

by a relatively disadvantaged group. The reduction of the maximum limit aims to limit the share of resources received by the most favored part of the population. The income and wealth decrystallization aims to eliminate the disproportionate advantages in education, political power, and social acceptability that may be linked to an advantage (disadvantage) in income or wealth. The objective of the international baseline is that a given nation in analysis should not be more unequal than another comparable nation (Cowell, 2011).

FIGURE 1 PERSPECTIVES FOR INTERPRETATION OF INEQUALITY

Source: Adapted from Cowell (2011).

In addition, Cowell (2011) incorporates additional elements to the measurement of inequality: (i) the specification of the social unit of measure — individual, the nuclear family or the extended family; (ii) the description of the attribute of the dependent variable: income, wealth, land ownership, voting power, etc.; (iii) the method of representation or aggregation of income allocation among people in a given population.

Therefore, two fundamental characteristics to assess inequality are: measurability and comparability among different people (Cowell, 2011).

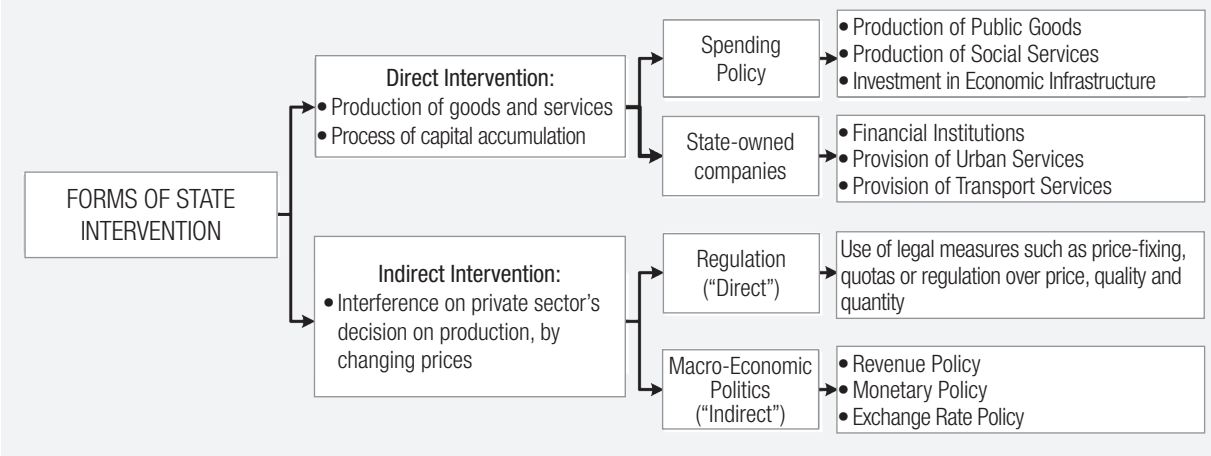
2.2 ECONOMIC FUNCTIONS OF BUDGET

Keynesians argued that the government should intervene in the economy by way of fiscal and monetary policies in order to promote full employment, price stability, and economic growth (Keynes, 1996).

To combat recession or depression, the government should increase its spending or reduce taxes, and this option would increase spending on private consumption. Also, the government should make more money available at lower interest rates in the expectation that this increases investment. As for controlling inflation caused by excessive aggregate spending, the government should reduce its own spending, raise taxes to reduce spending on private consumption or reduce the money supply to raise interest rates, which would curb excessive investment spending (Brue, 2005).

Figure 2 illustrates a detailed view of the forms of State intervention in the economy.

FIGURE 2 FORMS OF STATE INTERVENTION IN ECONOMY



Source: Adpated from Rezende (2001).

As observed in Figure 2, the State can intervene in the economy directly and indirectly. Among the forms of direct intervention are the spending policy and state-owned companies (Rezende, 2001). In the spending policy, which is reflected in the budget, the State acts as the main client of the internal market, whereas the State-owned companies act in strategic sectors of the industry.

Among the forms of indirect intervention, revenue and regulatory policies stand out (Rezende, 2001). Revenue policy, which is directly related to the tax system, comprises, among other measures, raising taxes or the waiver of revenues. As for regulation, the government works through its regulatory agencies to interfere in price, quality, and quantity of public concessions.

Following a similar line of State intervention in the economy, Musgrave and Musgrave (1980) established that it is the competency of the State to perform three typical functions: (i) allocation; (ii) distribution; and (iii) stabilization.

Thus, the budget plan must achieve three objectives: ensure adjustments in the allocation of resources; efficiently organize the distribution of income and wealth; and ensure economic stability. Table 1 below shows the characteristics of the functions:

TABLE 1 ECONOMIC FUNCTIONS OF BUDGET

Function	Characteristic
Allocation	It is comprised of provision of public goods, or process dividing the use of total resources of economy between public and private goods, as well as the process through which the composition of public goods is selected. Public goods cannot be offered as society needs by the market system. The fact that the benefits generated by public goods are available for all consumers implies no voluntary payment to suppliers of these goods. Thus, government is responsible to determine the type and quantity of public goods to be offered, as well as calculate the level of contribution for each consumer. In addition to the pure public goods, the State can provide semi-public goods such as education and health. These goods, despite being rivals and exclusives, and can be supplied by the market, present positive externalities that justify their provision or subsidy by the public sector.
Distribution	This function refers to income distribution, resulting from factors of production — capital, work and land — and selling of these factors' services in the market. It can be applied by using transference mechanisms, progressive taxes and subsidies ensuring conformity with what society considers a fair distribution.
Stabilization	Relates to the use of budgetary policy with the aim of keeping full employment. This policy can be expressed directly, by the variation of public spending in consumption and investment; by the reduction of tax rates, which increases private sector's disposable income.

Source: Musgrave and Musgrave (1980).

Based on the concept of economic functions of budget, the following variables were identified: for allocation — spending on health and education; for distribution — progressive taxes and transfers of direct income; for stabilization — inflation and employment rate. This study focuses on the allocation function.

2.3 STATE OF THE ART ON THE ALLOCATION FUNCTION AND THE REDUCTION OF SOCIAL INEQUALITIES

Several studies have sought to assess the effects of fiscal variables on inequality. However, as explained in section 2.1, it is possible to analyze inequality on different perspectives, which brings a plurality of methods and dependent and independent variables to the discussion.

Table 2 presents the studies of researchers who sought to find the relationship between the elements of the allocation function and income inequality. Meltzer and Richard (1983), Perotti (1992), Easterly and Rebelo (1993), Perotti (1996), Lindert (1996), Gouveia and Masia (1998), Bassett, Burkett, and Putterman (1999), Rodriguez (1999), Tanninen (1999), Castronova (2001), Jha, Biswal, and Biswal (2001), Sylwester (2002), Bergh and Fink (2008), Zhang (2008), Holzner (2010) as well as Araújo, Alves, and Bessaria(2013) used public spending and elements of the allocation function, in an attempt to assess their impact on the reduction of social inequalities.

Out of the main areas of spending used in these studies, those that stand out, according to Musgrave and Musgrave (1980), generate positive externalities: education and health. These variables appeared in a special way in the studies of: Bassett, Burkett, and Putterman (1999), Jha, Biswal, and Biswal (2001), Sylwester (2002), Mello and Tiongson (2006), Bergh and Fink (2008), and Zhang (2008). In other studies, they were included, but not prominently.

TABLE 2 PREVIOUS STUDIES ON INEQUALITIES AND ALLOCATION FUNCTION

Source	Sample	Period	Data Structure	Measures		Correlation	
				Allocation function	Inequality function	1Signal	Significance
Meltzer and Richard (1983)	Average of the States in the US	1937-77	Time series	Public spending	Ratio of mean to median income	Positive	Significant
Perotti (1992)	40 countries	1970-85	Time series of countries' average	Public spending	[1]Q3 in 1970	Negative	Non-significant
Perotti (1996)	49 countries	1970-85	Time series of countries' average	Taxes and public spending	Q3 and Q4 in 1960	Usually positive	Usually non-significant
Lindert (1996)	14 OCDE countries	1962-81	Panel OLS (OLS)	Public spending	Variation of the income ratio	Negative	Usually non-significant
Partridge (1997)	48 States in the US	1960-90	Panel OLS	Taxes, employment and spending	Gini coefficient before taxes, Q3	Inconsistent	Usually significant
Gouveia and Masia (1998)	50 States in the US	1979-91	Panel OLS	Public spending	Ratio of mean to median income	Usually negative	Usually significant
Figini (1998)	63 countries	1970-90	Time series of countries' average	Taxes, total income and total spending	Gini coefficient in 1970	Inconsistent	Significant
Bassett, Burkett and Putterman (1999)	54 countries	1970-1985	Time series of countries' average	Social security and welfare	Q3 in 1960	Usually negative	Inconsistent
Rodriguez (1999)	50 States in the US	1984-94	Time series of States' average	Public spending	Asymmetric distribution	Inconsistent	Non-significant
Tanninen (1999)	45 countries	1970-88	Time series of countries' average	Public spending	Adjusted Gini coefficient	Inconsistent	Usually non-significant
Milanovic (2000)	24 OCDE countries	1967-97	Panel OLS	Income of the poorer 20% or 50% of the population	Adjusted Gini coefficient before taxes	Positive	Significant
Source	Sample	Period	Data Structure	Measures		Correlation	
				Allocation function	Inequality function	[1]Signal	Significance
Castronova (2001)	13 OCDE countries	1962-91	OLS and OLS in 02 stages	Social spending	Per capita income	Inconsistent	Significant
Jha, Biswal and Biswal (2001)	14 States in India	1957-97	Panel OLS	Spending on education and health	Poverty rate: longevity, literacy, access to provision (health care, treated water, children under 5 years old with adequate weight)	Positive (spending with higher education and technology education are more effective than spending with primary education)	Significant

Continue

Source	Sample	Period	Data Structure	Measures		Correlation	
				Allocation function	Inequality function	1Signal	Significance
Panizza (2002)	46 States in the US	1970-80	Time series of States' average	Taxes, progressive taxes and public spending	Q3 in 1970	Usually positive	Inconsistent
Sylwester (2002)	50 countries	1970-90	Panel OLS	Spending on education	Gini coefficient	Negative	Significant
Mello and Tiongson (2006)	Between 49 and 55 countries	1972-98, and 1970-98	Panel OLS e panel tobit	Spending on social security (health included) and welfare (percentage of GDP); Transfers (percentage of GDP)	Gini coefficient, per capita income, percentage of the population over 65 years old, democracy index	Negative	Usually significant
Bergh and Fink (2008)	35 countries	1980-2000	Panel OLS	Spending on education	Gini coefficient	Positive	Significant
Zhang (2008)	50 countries	1970-90	Panel OLS	Spending on education, separated in secondary and high education	Gini coefficient	Negative for secondary education and positive for higher education	Significant
Holzner (2010)	28 countries from Central, East and Southeast Europe	1989-2006	Generalized least squares	Spending	Gini coefficient	Spending with social protection and health were negatively related	Significant
Araújo, Alves and Bessaria (2013)	Brazilian States	2004-09	Panel fixed effects	Spending on education, health care and the federal conditional cash transfer program (Bolsa Família)	Number of people in households with per capita household income below the line of extreme poverty; Number of people in households with per capita income below the line of poverty; Gini coefficient and Theil-T coefficient	Negatively related	Significant only for poverty indicators

Source: Elaborated by the Authors
Note: [1] Q3 — proportion of the income obtained by the 3º quintile of the population. Larger the proportion, smaller the inequality.

The studies by Jha, Biswal, and Biswal (2001), Sylwester (2002), Mello and Tiongson (2006), Bergh and Fink (2008), Zhang (2008), Holzner (2010) and Araújo, Alves, and Bessaria (2013) specifically used spending on health or education.

From the results found in previous studies and considering the theory, the central hypothesis of this research is established as follows: *the States of Brazil that present a higher volume of spending on education and health reduced income inequality, ceteris paribus.*

The choice for the States spending on education and health was made because these areas that lead to positive externalities by reducing income inequality in line with the social minimum, inclusive economy, and decrystallization of wealth, considering the above in Figure 1 of section 2.1.

In order to expand the possibilities of the study, the element of royalties was included. Studies by Sousa, Cribari-Neto and Stosic (2005) identified that the Brazilian municipalities that receive substantial royalties tend to be less efficient, then suggesting that extra revenue, instead of encouraging full use of resources, contributes to the relaxation of fiscal constraints and increased inefficiency.

3. METHODOLOGY OF EMPIRICAL ANALYSIS

This section will present the techniques used for quantitative data analysis, as well as detailing the functional models, econometric models and variables that serve as proxies to test the research hypothesis stated in the previous section.

3.1 SAMPLING

The population in this study is made up of all of the Brazilian States. The data was collected for each of the 18 years referring to the period from 1995 to 2012, of the 26 Brazilian States, including the Federal District. Table 3 contains the variables and sources of data.

TABLE 3 VARIABLES, SOURCES OF DATA AND LIMITATIONS

Variables	Source of the data	Limitation
GDP	Ipeadata[1]	-
Gini coefficient; Theil coefficient; Ratio between the richest 10% and the poorest 40%; Ratio between the richest 20% and the poorest 20%	Ipeadata	For absent data for the years 2000 and 2010, the authors used exponential interpolation
Spending on education and health in States and municipalities: functional budget classification per function and subfunction	Nacional Treasury Secretariat[2]	Before 2001, spending on education was together with spending on culture, and health was together with sanitation. Between 1995 (included) and 2003 (included), the subfunctions were not separated. The authors used a correction model in order to obtain this data.[3]

Continue

Variables	Source of the data	Limitation
Revenues from oil royalties	Brazilian National Agency of Petroleum, Natural Gas and Biofuels[4]	Absent data for 1995 and 1996
Revenues from royalties paid by the electricity sector	Brazilian Electricity Regulatory Agency[5]	Absent data for 1995 and 1996

Source: Elaborated by the authors

[1] Available at: <www.ipeadata.gov.br/>.

[2] Available at: <www.tesouro.fazenda.gov.br/pt/contas-anuais>.

[3] In the case of spending on health and education, it was considered the mean in each State: the sum of the expenses on health between 2004 and 2012 was divided by the sum of the expenses on health and sanitation between 2004 and 2012. The result was multiplied by the amount of expenses on health and sanitation, year by year, from 1995 to 2003.

[4] Data was provided by the system E-SIC: <www.acessoainformacao.gov.br/sistema/site/index.html?ReturnUrl=%2fsistema%2f>, protocol 48700006560201500 of August 31st 2015.

[5] Available at: <www.aneel.gov.br/aplicacoes/cmpf/gerencial/>.

The year 1995 was the first year of the "Real", an economic plan that generated credit stability and provided family planning (which may have also contributed to the reduction of income inequality during the study period). However, this phenomenon will not be explored.

3.2 THE PROPOSED MODEL AND RESEARCH VARIABLES

The study of Lundberg and Squire (2003) uses equation 1 as a reference.

$$Gini_{it} = \alpha + S'_i \varpi + Z'_i \psi + e_i \quad (1)$$

The equation states that inequality "Gini" of a country in a region or country "i" at a period "t" is a function of variables related to the vector of economic growth and inequalities (S_{it}) and of the vector of variables related with the vector of inequalities without relation to economic growth (*Zit*).

From the adjusted previous functional model and considering the research hypothesis: *the States of Brazil that present higher volume of spending on education and health reduced income inequality, ceteris paribus*; the functional model was provided as in equation 2.

$$DES_{i,t,j} = f\left(\frac{DEDU_{i,t,s}}{PIB_{i,t}}; \frac{DSAU_{i,t,s}}{PIB_{i,t}}\right) \quad (2)$$

Where the income inequality index (DES) in a certain State "i" is a function of percentage expenditures on education (DEDU) and health (DSAU) of a certain public entity "i" in a determined period "t". The "j" attribute identifies different variables to measure income inequality. The "s" attribute identifies the aggregation of expenditures that one wishes to highlight. The econometric model in equation 3 is presented as follows.

$$DES_{i,t,j} = \beta_0 + \beta_1 \frac{DEDU}{PIB}_{i,t,s} + \beta_2 \frac{DSAU}{PIB}_{i,t,s} + \beta_3 RNE_1(1) + \beta_4 RCO_2(1) + \beta_5 RSE_3(1) + \beta_6 RSU_4(1) + \beta_7 \frac{ROYP}{PIB}_{i,t} + \beta_8 \frac{ROYSE}{PIB}_{i,t} + \varepsilon_{i,t} \quad (3)$$

Considering the index DES, income inequality, of a given State "i" is a function of percentage expenditure on education and health of this State in a given period "t". The "j" attribute identifies the different variables of inequality: the Gini coefficient, the Theil coefficient, the ratio between the richest 10% and poorest 40%, the ratio between the richest 20% and poorest 20%. The "s" attribute identifies whether the expenses in question are: only State, only municipal, or State and municipal consolidated.

The "RNE" dummy variable identifies the States of the Northeast, the "RCO" dummy variable identifies the States of the Midwest, the "RSE" dummy variable identifies the States of the Southeast, the "RSU" dummy variable identifies the States of the South.

The "Royp" variable contains the amounts received from oil royalties by States and municipalities and the variable "Royse" refers to royalties received from the electricity sector by States and municipalities. Table 4 provides a breakdown of variables.

Both the functional model and the econometric model only consider variables of allocation function such as health and education. They do not consider progressive taxes or transfers of income directly related to the distribution function.

TABLE 4 VARIABLES DESCRIPTION AND EXPECTED SIGNAL

Variables	Description	Observed effect	Expected signal
Gini	Dependent variable represented by the Gini index of the state in the period "i" (from 1995 to 2012).The index is a number between 0 and 1, where 0 means complete income equality and 1 complete income inequality	Income inequality	Dependent Variable
Theil	The Theil index is given by the Napierian logarithm of ratio between the arithmetic and geometric means of average family *per capita* income. If the ratio of means is equal to 1, Theil will equal 0, which indicates perfect distribution		
P10-40	Palma ratio: ratio of the share of the richest 10% of the population and that of the poorest 40%. Lower the ratio, lower inequality		
P20-20	Ratio of the share of the richest 20% and the poorest 20%. Lower the ratio, lower inequality		
DSAU/PIB	Independent variable represented by the resources allocated on health, divided by the State's GDP	Effects of the allocation function on reducing income inequality	(-)
Dedu/PIB	Independent variable represented by the resources allocated on education, divided by the State's GDP		(-)
RNE, RCO, RSE, RSU	Polychotomous dummy variable that represents the 5 regions of Brazil: North, Northeast, Midwest, Southeast and South. North is the region of reference	Differences between the regions	?
Royp/PIB	Independent variable represented by the resources received as oil royalties, divided by the State's GDP	Effects of the resources received as royalties on reducing income inequality	(-)
Royse/PIB	Independent variable represented by the resources received as royalties paid by the electricity sector, divided by the State's GDP		(-)

Source: Elaborated by the authors

Spending on education and health generate positive externalities and can contribute to the reduction of income inequality in the perspectives of the social minimum, inclusive economy and the decrystallization of wealth. Therefore, the tendency is that the larger the amount of resources, the lower the income inequality is (Cowell, 2011; Giacomoni, 2012).

The Federal Constitution of Brazil from 1988 establishes that education and health are social rights guaranteed to all citizens.[1]

Education and health, when well distributed and offered with equality, tend to ensure the social minimum because they ensure that everyone has a minimum standard of wellbeing; reduce the feeling of exclusion from society caused by differences in income; and because they aim to eliminate the disproportionate advantages in education (Cowell, 2011).

Those who receive substantial income from royalties tend to have more resources to allocate for education and health; therefore, they would be more likely to reduce income inequality.

3.3 METHODS TO EVALUATE THE PROPOSED MODEL

The econometric model proposed in equation (3) was analyzed according to the panel data analysis with fixed effects and the tobit regression on panel data. The tobit regression on panel data was conducted with the aim of testing whether the specification of the truncated dependent variable would have a better performance. Thus, the intention is to validate the results through using two distinct approaches.

Panel data analysis with fixed effects is more appropriate when the units of observation in the sample are the entire population. In addition, it requires that the intercept in the regression model is different for the observation units (i), but not over time (t); and that all estimates of slope coefficients are fixed for observation units (i) and time (t) (Baltagi, 2005).

The tobit panel has the following characteristics: (i) the model is linear; (ii) the dependent variable is continuous and censored in the range between 0 and 1. The fact that the dependent variable is censored indicates that the estimation of parameters by Ordinary Least Squares is not appropriate, which justifies the use of the tobit model. In the tobit model the parameters are estimated by maximum likelihood; (iii) the model combines the observation units (States) over time; (iv) it is evident that there is heterogeneity between the States, justifying the existence of panel data (Baltagi, 2005).

Considering the features of the dependent variables, the OLS fixed effects tend to be more suitable for the dependent variables P10-40 and P20-20, while the tobit panel tends to be more suitable for the Gini and Theil dependent variables.

4. RESULTS AND ANALYSIS

This section presents the research results. Subsection 4.1 presents descriptive data of the research's main variables. In subsection 4.2, spending is presented by function: health and education, whereas in subsection 4.3 spending is presented by subfunction (second level of function). This measure for section 4.3 was necessary from the results obtained in section 4.2.

[1] Art. 6. In the form stated in this constitution, social rights are considered as: education, health, food security, labor, housing, transportation, leisure, safety, social insurance, protection to maternity and childhood, assistance to those in extreme need (Brazil, 1988).

4.1 DESCRIPTIVE DATA FROM THE MAIN VARIABLES USED

TABLE 5 PARTICIPATION OF BRAZILIAN REGIONS IN NATIONAL GDP

Year	North	Northeast	Southeast	South	Midwest	Total Amount (R$ billions in nominal value)
1950	1.71%	14.47%	66.0%	16.1%	1.72%	*
1960	2.30%	14.53%	63.59%	17.26%	2.32%	*
1970	2.22%	11.92%	65.21%	17.29%	3.61%	*
1980	3.33%	12.17%	62.19%	17.11%	5.02%	*
1985	4.22%	13.83%	59.45%	15.96%	5.39%	*
1990	5.02%	14.06%	58.38%	17.35%	6.58%	*
1995	4.86%	13.65%	57.25%	17.7%	6.89%	705
2000	4.4%	12.4%	58.3%	16.5%	8.4%	1.179
2005	4.96%	13.07%	56.53%	16.59%	8.86%	2.147
2010	5.34%	13.46%	55.39%	16.51%	9.3%	3.770
2012	5.27%	13.56%	55.19%	16.18%	9.8%	4.392

Sources: IBGE[2] (2015) and Ipeadata (2015).
Note: * it was not considered due to the changes in the currency.

It is possible to observe that in 1950, around 82% of the wealth was concentrated in the South and Southeast regions, whereas in 2010, this percentage dropped to 72%. In 60 years, there was a redistribution of only 10% in wealth generation. An important factor is that in absolute terms, the GDP in the Northeast region, went from R$ 84 billion in 1995 to R$ 508 billion in 2010, an increase of 600%. In the Southeast, GDP went from R$ 417 billion in 1995 to R$ 2.088 billion in 2010, an increase of 500%. Therefore, it is important to recognize that there was an incremental increase in the generation of wealth in all regions, even though the concentration in the Southeast persists.

Table 6 below presents data about the population.

[2] The GDP of the States for the years 2010, 2011 and 2012 published by IBGE (Brazilian Institute for Geography and Statistics) in the quadrennial 2010-13 diverge from the numbers presented by IPEA (Institute for Applied Economic Research). According to the Information Service of the institute in response to the author's demand (protocol nº 00089000004201631), the numbers for 2014 will be available in November 2016.

TABLE 6 POPULATION IN BRAZILIAN REGIONS

Year	North	Northeast	Southeast	South	Midwest	Total Population (million)
1950	3.94%	34.6%	43.41%	15.09%	2.95%	51.9
1960	4.13%	31.51%	43.87%	16.75%	3.74%	70.3
1970	4.43%	30.18%	42.79%	17.71%	4.89%	93.1
1980	5.56%	29.25%	43.47%	15.99%	5.72%	119
1985	6.21%	29.10%	43.10%	15.53%	6.07%	131.64
1990	6.73%	28.97%	42.79%	15.15%	6.36%	144.09
1995	7.16%	28.86%	42.54%	14.97%	6.59%	155.82
2000	7.60%	28.12%	42.65%	14.79%	6.85%	169.8
2005	7.98%	27.70%	42.61%	14.64%	7.07%	184.18
2010	8.32%	27.83%	42.13%	14.36%	7.37%	190.8
2012	8.43%	27.79%	42.05%	14.30%	7.44%	193.98

Sources: Datasus (2015) and Ipeadata (2015).

When comparing the proportion of population distribution in table 6 with the proportion of wealth in table 5, it is possible to observe that one of the most disadvantaged regions — in terms of percentage — is the Northeast.

Tables 7 and 8 present indicators of income inequality in Brazilian regions.

TABLE 7 EVOLUTION OF GINI COEFFICIENT IN BRAZILIAN REGIONS

Year	North	Northeast	Southeast	South	Midwest
1979	0.530	0.557	0.557	0.564	0.561
1985	0.549	0.595	0.567	0.561	0.587
1990	0.583	0.626	0.577	0.577	0.611
1995	0.584	0.604	0.567	0.565	0.585
1999	0.565	0.605	0.559	0.562	0.593
2005	0.530	0.571	0.543	0.515	0.577
2009	0.522	0.558	0.511	0.491	0.560
2012	0.513	0.542	0.505	0.468	0.531

Source: Ipeadata (2015).

TABLE 8 EVOLUTION OF THEIL-T COEFFICIENT IN BRAZILIAN REGIONS

Year	North	Northeast	Southeast	South	Midwest
1979	0.557	0.691	0.622	0.665	0.617
1985	0.622	0.807	0.638	0.644	0.708
1990	0.722	0.881	0.676	0.660	0.777
1995	0.713	0.810	0.645	0.645	0.689
1999	0.639	0.801	0.620	0.627	0.736
2005	0.577	0.705	0.594	0.523	0.712
2009	0.554	0.666	0.527	0.479	0.664
2012	0.529	0.676	0.551	0.450	0.599

Source: Ipeadata (2015).

During the period from 1995 and 2012 the indicators of income inequalities improved. The South is the least and the Northeast the most unequal regions. Tables 9 and 10 show nominal values of State and municipal spending separated by regions, in the period covered by this study.

TABLE 9 EVOLUTION OF THE SPENDING ON EDUCATION — STATE AND MUNICIPAL SPENDING — NOMINAL VALUES IN R$ BILLIONS

Year	North	Northeast	Southeast	South	Midwest
1995	1.34	3.45	12.32	3.48	1.82
2000	3.01	8.97	25.81	7.37	3.51
2005	5.67	16.46	41.96	11.58	5.55
2010	12.47	35.69	72.09	23.32	12.99
2012	15.63	43.29	88.32	28.61	15.39

Source: Ipeadata (2015).

TABLE 10 EVOLUTION OF THE SPENDING ON HEALTH — STATE AND MUNICIPAL SPENDING — NOMINAL VALUES IN R$ BILLIONS

Year	North	Northeast	Southeast	South	Midwest
1995	0.80	2.23	7.76	1.45	0.93
2000	1.51	4.91	14.27	3.6	1.95
2005	4.90	14.19	30.97	9.11	5.05
2010	9.95	30.00	58.89	17.86	9.88
2012	11.89	37.17	74.58	23.14	12.99

Source: Ipeadata (2015).

The Southeast has the largest amount of resources allocated to education and health, followed by the Northeast.

4.2 EVALUATION OF SPENDING PER FUNCTION

The results are presented considering 3 statistical methods: (i) panel data analysis; (ii) panel data analysis with fixed effects, (iii) tobit panel data. 03 tables are presented for each method: (i) State spending, (ii) municipal spending broken down by state, (iii) state and municipal spending broken down by state.

Tables 11, 12 and 13 show the tests results using panel data analysis.

TABLE 11 RESULTS OF PANEL DATA ANALYSIS: STATE SPENDING

Dependent Variables	Gini	Theil	P10-40	P20-20
Constant	0.557231***	0.648005***	18.1708***	19.9547***
DSAU/PIB	–0.861057***	–2.51383***	–73.6670***	–62.2865**
Dedu/PIB	0.327670***	0.815862***	33.6083***	35.1267***
RNE	0.0322555***	0.119373***	3.34773***	3.02151***
RCO	0.00669244	0.00531743	1.39167**	1.51587*
SER	–0.00816456	–0.0297818	–0.792370	–1.01775
RSU	–0.0377572***	–0.108434***	–2.98168***	–2.80039***
Royp	–1.37777	–6.66002**	–221.108**	–311.268**
Royse	–5.86680	–1.20787	–1325.64***	–2219.73***

Continue

Dependent Variables	Gini	Theil	P10-40	P20-20
Fixed effects	No	No	No	No
Random effects	No	No	No	No
R-squared	0.278211	0.340587	0.248975	0.196890
Adjusted R-squared	0.266106	0.329527	0.236379	0.183421
Durbin-Watson test	0.537013	0.803676	0.534099	0.566944
Normality of residuals (p-value)	0.13759	0.00000	0.00000	0.00000
Chow test (p-value)	1.06413e-038	4.88025e-021	6.74352e-049	3.2329e-048
Breusch-Pagan test (p-value)	3.93286e-081	1.05677e-036	2.40179e-114	1.18791e-112
Hausman test (p-value)	0.000151222	0.002047	0.000190723	0.000309942
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

TABLE 12 RESULTS OF PANEL DATA ANALYSIS: MUNICIPAL SPENDING

Variables	Gini	Theil	P10-40	P20-20
Constant	0.564414***	0.629453***	19.8008***	22.1233***
DSAU/PIB	–3.24996***	–8.36520***	–360.445***	–432.942***
Dedu/PIB	1.44029***	4.87553***	147.592***	193.594***
RNE	0.0559801***	0.171950***	5.90264***	5.70446***
RCO	0.0160185***	0.0458700***	1.97206***	1.98641***
RSE	0.00173748	0.0101212	–0.169669	–0.597139
RSU	–0.0327243***	–0.0775846***	–2.94343***	–3.04654***
Royp	–1.72736**	–7.59521***	–245.021***	–317.034***
Royse	3.87458	17.6831	–187.318	–949.273*
Fixed effects	No	No	No	No
Random effects	No	No	No	No
R-squared	0.422755	0.413631	0.429152	0.377689
Adjusted R-squared	0.413074	0.403797	0.419579	0.367252
Durbin-Watson test	0.661319	0.887954	0.694137	0.741462
Normality of residuals (p-value)	0.00013	0.00000	0.00619	0.00000
Chow test (p-value)	0.000714581	2.8859e-020	3.68032e-040	3.4422e-039
Breusch-Pagan test (p-value)	6.15707e-083	3.66954e-036	6.58466e-126	1.00119e-124
Hausman test (p-value)	0.296805	0.00603599	0.498546	0.663392
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

TABLE 13 RESULTS OF PANEL DATA ANALYSIS: STATE AND MUNICIPAL SPENDING

Variables	Gini	Theil	P10-40	P20-20
Constant	0.575969 ***	0.673872***	20.6867***	22.9968***
DSAU/PIB	–1.19773***	–2.81451***	–127.867***	–137.282***
Dedu/PIB	0.368970***	0.926702***	39.4913***	44.4418***
RNE	0.0381549***	0.138783***	3.78629***	3.32858***
RCO	0.000697084	0.00197931	0.432325	0.259102
SER	–0.0148291**	–0.0333564**	–1.87158***	–2.44677***
RSU	–0.0470369***	–0.117858***	–4.34633***	–4.53758***
Royp	–0.980718	–6.03399**	–165.616*	–238.241**
Royse	–1.26587	9.92894	–849.142*	–1723.97***
Fixed effects	No	No	No	No
Random effects	No	No	No	No
R-squared	0.363055	0.386996	0.340358	0.276668
Adjusted R-squared	0.352372	0.376715	0.329294	0.264537
Durbin-Watson test	0.630880	0.887221	0.621869	0.638450
Normality of residuals (p-value)	0.00020	0.00000	0.00000	0.00000
Chow test (p-value)	1.08765e-038	6.4103e-022	5.56765e-051	5.29794e-050
Breusch-Pagan test (p-value)	2.49262e-105	2.4596e-044	3.908e-157	1.12148e-154
Hausman test (p-value)	0.095839	0.0222347	0.169614	0.217366
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

It is possible to observe in table 11 that the larger the proportion of spending on health on the GDP, the higher the tendency to reduce income inequality. This result is similar with the result shown by Jha, Biswal and Biswal (2001) and Holzner (2010), and with the assumptions from Cowell (2011) and Giacomoni (2012).

The idea is the same for the proportion of oil royalties and the royalties payed by the electricity sector. The regional effect was significant in the regions Northeast and South in comparison to the North. These results are valid for the 4 indicators of income inequality selected in the research.

As for the diagnostic of the panel, in the 4 cases, considering the results of Chow and Breusch -Pagan tests, it is possible to conclude that the model of panel data would be more adequate than the

pooled model. Regarding Hausman test, it is observed that the panel data with fixed effects would be preferred over the panel data with random effects.

In table 12, which considers the municipal spending on education and health broken down by State, the results were similar to the ones in table 5. The differences are: the regional effect became significant in the Midwest region; the panel data with fixed effects is still preferred for the dependent variable Theil, whereas the panel data with random effect is preferred for the variables: Gini, P10-40 (ratio between the richest 10% and the poorest 40%) and P20-20 (ration between the richest 20% and the poorest 20%).

In table 13, which considers State and municipal spending separated on spending on education and health, the results were similar of those in table 5. The differences found are: the regional effect became significant in the Southeast; the panel data with fixed effects is still the preferred for the variables Gini and Theil, whereas the panel with random effects is preferred for the variables P10-40 (ratio between the richest 10% and the poorest 40%) and P20-20 (ratio between the richest 20% and the poorest 20%).

In tables 11, 12 and 13 it is observed a high level of agreement regarding the signals of the independent and the dependent variables.

Tables 14, 15 and 16 present the results of the tests using OLS — fixed effects. It is important to clarify that it is not possible to use regional dummies in this method.

TABLE 14 RESULTS OF PANEL DATA ANALYSIS WITH FIXED EFFECTS: STATE SPENDING

Variables	Gini	Theil	P10-40	P20-20
Constant	0.592726***	0.735866 ***	22.2565***	24.4729***
DSAU/PIB	–2.20860***	–5.26054 ***	–234.328***	–262.643***
Dedu/PIB	0.340259***	0.847441***	37.4276***	39.5296***
Royp	–3.72202***	–8.72846**	–426.184***	–408.912***
Royse	–9.07689	–36.0064*	–1150.30*	–1364.84*
Fixed effects	Yes	Yes	Yes	Yes
Random effects	No	No	No	No
R-squared LSDV	0.579131	0.531235	0.607876	0.577571
Durbin-Watson test	0.918010	1.128508	1.001112	1.042782
Joint test on designated regressors (p-value)	1.74095e-027	6.23714e-018	1.07511e-029	4.4491e-025
Test to differ groups intercepts (p-value)	9.23604e-065	2.03079e-056	3.12146e-070	1.02035e-061
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

TABLE 15 RESULTS OF PANEL DATA ANALYSIS WITH FIXED EFFECTS: MUNICIPAL SPENDING

Variables	Gini	Theil	P10-40	P20-20
Constant	0.595625***	0.740833****	22.8158***	24.6266***
DSAU/PIB	–3.48849***	–9.52842***	–376.607***	–462.995***
Dedu/PIB	1.12573***	3.74239***	114.476***	177.321***
Royp	–1.44971	–3.16433	–165.24	–133.541
Royse	–3.68855	–20.0668	–502.433	–605.605
Fixed effects	Sim	Sim	Sim	Sim
Random effects	Não	Não	Não	Não
R-squared LSDV	0.632069	0.579179	0.671934	0.638438
Durbin-Watson test	1.066626	1.257810	1.215029	1.267251
Joint test on designated regressors (p-value)	1.24649e-040	2.01207e-028	3.69096e-047	2.77158e-040
Test to differ groups intercepts (p-value)	3.32773e-072	6.21403e-060	9.69024e-081	6.7653e-068
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

TABLE 16 RESULTS OF PANEL DATA ANALYSIS WITH FIXED EFFECTS: STATE AND MUNICIPAL SPENDING

Variables	Gini	Theil	P10-40	P20-20
Constant	0.603123***	0.761642***	23.4786***	25.7469***
DSAU/PIB	–1.52046 ***	–3.72834***	–165.166***	–183.620***
Dedu/PIB	0.229978***	0.617514***	25.4159***	27.8046***
Royp	–2.01167*	–4.49039	–237.276**	–198.135
Royse	–3.36522	–21.2346	–496.564	–645.774
Fixed effects	Sim	Sim	Sim	Sim
Random effects	Não	Não	Não	Não
R-squared LSDV	0.628507	0.568643	0.663121	0.626674
Durbin-Watson test	1.019841	1.212787	1.139257	1.175751
Joint test on designated regressors (p-value)	1.0956e-039	5.18993e-026	1.47046e-044	3.7893e-037
Test to differ groups intercepts (p-value)	1.70855e-074	3.35893e-063	4.94836e-082	1.22708e-070
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

In tables 14, 15 and 16, it is noted that the larger the proportion of spending on health on the GDP, the higher the tendency of reducing income inequality. Once more, the controversial result related to spending on education is repeated. This demands a deeper analysis starting from the expenditures break down.

The expected signal of the independent variables related to the royalties was in agreement in the 03 tables, even though they are not always statistically significant. This result confirms the previous assumption that the Brazilian territories that present a larger proportion of royalties on the GDP tend to reduce inequality more intensively.

Tables 17, 18 and 19 present the results of tests using tobit panel.

TABLE 17 RESULTS OF TOBIT PAINEL: STATE SPENDING

Variables	Gini	Theil	P10-40	P20-20
Constant	0.557231***	0.648419***	18.1708***	19.9547***
DSAU/PIB	–0.861057***	–2.54981***	–73.6670***	–62.2865**
Dedu/PIB	0.327670***	0.827750***	33.6083***	35.1267***
RNE	0.0322555***	0.117022***	3.34773***	3.02151***
RCO	0.00669244	0.00502309	1.39167**	1.51587*
SER	–0.00816456	–0.0304459*	–0.792370	–1.01775
RSU	–0.0377572***	–0.108842***	–2.98168 ***	–2.80039***
Royp	–1.37777	–6.38195**	–221.108**	–311.268**
Royse	–5.86680	–1.04253	–1325.64***	–2219.73***
Normality of residuals (p-value)	0.18012	0.00601954	1.86671e-009	1.4784e-022
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

TABLE 18 RESULTS OF TOBIT PANEL: MUNICIPAL SPENDING

Variables	Gini	Theil	P10-40	P20-20
Constant	0.564414***	0.629453***	19.8008***	22.1233***
DSAU/PIB	–3.24996***	–8.36520***	–360.445***	–432.942***
Dedu/PIB	1.44029***	4.87553***	147.592***	193.594***
RNE	0.0559801***	0.171950***	5.90264***	5.70446***
RCO	0.0160185***	0.0458700 ***	1.97206***	1.98641***
SER	0.00173748	0.0101212	–0.169669	–0.597139
RSU	–0.0327243***	–0.0775846***	–2.94343***	–3.04654***
Royp	–1.72736**	–7.59521***	–245.021***	–317.034***
Royse	3.87458	17.6831	–187.318	–949.273*

Continue

Variables	Gini	Theil	P10-40	P20-20
Normality of residuals (p-value)	8.50279e-005	0.0297881	0.0100489	3.5735e-008
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

TABLE 19 RESULTS OF TOBIT PANEL: STATE AND MUNICIPAL SPENDING

Variables	Gini	Theil	P10-40	P20-20
Constant	0.575969***	0.673872***	20.6867***	22.9968***
DSAU/PIB	–1.19773***	–2.81451***	–127.867***	–137.282***
Dedu/PIB	0.368970***	0.926702***	39.4913***	44.4418***
RNE	0.0381549***	0.138783***	3.78629***	3.32858 ***
RCO	0.000697084	0.00197931	0.432325	0.259102
SER	–0.0148291***	–0.0333564**	–1.87158***	–2.44677***
RSU	–0.0470369***	–0.117858 ***	–4.34633***	–4.53758***
Royp	–0.980718	–6.03399**	–165.616*	–238.241**
Royse	–1.26587	9.92894	–849.142*	–1723.97***
Normality of residuals (p-value)	0.0122692	0.0294282	2.52766e-008	7.43537e-020
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

The results in the 3 tables above reinforce the results obtained in the previous tests pointing out that the larger the proportion of spending on health on the GDP, the higher the tendency of reducing income inequality. In the same way, there is a repetition of the same controversial result related to spending on education.

This result in education contradicts the result found by Jha, Biswal and Biswal (2001), Sylwester (2002), Mello and Tiongson (2006), Bergh and Fink (2008) and Zhang (2008). The result also contradicts the assumptions from Cowell (2001) and Giacomoni (2012).

In comparison to the model of the USA that emphasizes the primary and secondary education in allocating State's resources, granting to the private sector the most part of the initiative and responsibility when it comes to higher education, it is possible to observe that in Brazil the private sector competes with the State since primary education. Thus, whilst in the United States the majority of the population (of all social classes) attend public schools for primary and secondary education, in Brazil a considerable part of the population is attending primary and secondary education offered by the private sector.

Therefore, the Brazilian model in fact may not be aligned to reduce income inequality according to the doctrinal assumptions of the allocation function.

4.3 EVALUATION OF SPENDING BY SUBFUNCTION

Considering the results in the previous subsection, it is necessary to separate spending on education and on health in subfunctions. Therefore, the econometric model in equation 3 showing the spending functions education and health was broken down as presented in equation 4, by subfunctions of spending on health and education.

$$
\begin{aligned}
DES_{i,t,j} = {} & \beta_0 + \beta_1 \frac{AtBas}{PIB}_{i,t,s} + \beta_1 \frac{AssHosp}{PIB}_{i,t,s} + \beta_2 \frac{Suprofilat}{PIB}_{i,t,s} + \beta_3 \frac{VigSan}{PIB}_{i,t,s} + \beta_4 \frac{VigEpi}{PIB}_{i,t,s} \\
& + \beta_5 \frac{Ali}{PIB}_{i,t,s} + \beta_6 \frac{OutrasSau}{PIB}_{i,t,s} + \beta_7 \frac{Fund}{PIB}_{i,t,s} + \beta_8 \frac{Medio}{PIB}_{i,t,s} + \beta_9 \frac{Ensprof}{PIB}_{i,t,s} + \beta_{10} \frac{Supe}{PIB}_{i,t,s} \\
& + \beta_{11} \frac{Infantil}{PIB}_{i,t,s} + \beta_{12} \frac{EJA}{PIB}_{i,t,s} + \beta_{13} \frac{Especial}{PIB}_{i,t,s} + \beta_{14} \frac{OutrasEdu}{PIB}_{i,t,s} + \beta_{15} RNE_1(1) + \beta_{16} RCO_2(1) \\
& + \beta_{17} RNE_1(1) + \beta_{18} RCO_2(1) + \beta_{19} RSE_3(1) + \beta_{20} RSU_4(1) + \beta_{21} \frac{ROYP}{PIB}_{i,t} + \beta_{22} \frac{ROYSE}{PIB}_{i,t} + \varepsilon_{i,t}
\end{aligned}
\tag{4}
$$

As for the function of health, the variable "AtBas" represents spending on the subfunction primary health care. "AssHosp" means the spending on the subfunction hospital and outpatient care. "Suprofilat" means the spending on the subfunction prophylactic and therapeutic support. "VigSan" is the spending on the subfunction health surveillance. "VigEpi" is the spending on the subfunction "epidemiological surveillance". "Ali" is the spending on the subfunction food and nutrition. Finally, "OutrasSau" represents the spending on the subfunction "other expenditures on health". Regarding the function education, the variable "Fund" represents the spending on the subfunction primary education. "Medio" is the spending on the subfunction secondary education. The variable "Ensprof" represents the spending on professional education. The variable "Supe" the spending on the subfunction higher education. "Infantil" is the spending on the subfunction early childhood education. "EJA", the spending on adults' and young adults' education. "Especial" represents the spending on the subfunction special education. Finally, "OutrasEdu" represents the spending on the subfunction other expenditures on education. Other variables were presented in equation 3.

Tables 20, 21 and 22 show the results of the tests using tobit panel.

TABLE 20 RESULTS OF TOBIT PANEL: STATE SPENDING PER SUBFUNCTION

Dependent variables	Gini	Theil	P10-40	P20-20
Constant	0.567239***	0.680828***	19.3773***	21.2566***
Primary health care/GDP	–0.397113	–2.20166	30.5719	123.415
Hospital care/GDP	–0.280921	–1.01464*	–13.7024	–4.99535
Prophylactic support/GDP	–5.52664***	–18.3998***	–658.870***	–745.539***
Health surveillance/GDP	5.22978***	11.7557**	518.522***	496.918**
Epidemiological surveillance/ GDP	–10.3132	–46.3498*	–898.952	–541.118
Food and Nutrition/GDP	25.7000***	60.9533***	2293.44***	2498.67***

Continue

Dependent variables	Gini	Theil	P10-40	P20-20
Other expenditures on health/GDP	–1.13523***	–2.60327**	–88.3343**	–86.2024*
Primary education/GDP	0.0579263	–0.0263398	–3.34866	–3.42524
Secondary education/GDP	–0.0354357	–1.44602	–10.5688	59.5368
Professional education/GDP	–3.15187	–10.8978	–269.861	–356.995
Higher education/GDP	–0.489651	–0.431533	5.12441	–35.4990
Early childhood education/GDP	11.9802**	13.8384	1629.09***	1980.32***
Adults' and young adults' education/GDP	–3.97810	–14.9639	–517.383	–808.547
Special education/GDP	3.35274	6.49415	483.347	310.804
Other expenditures on education/GDP	0.185691	1.44529 **	6.71220	1.74036
RNE	0.0289955***	0.109902***	3.02599***	2.49557***
RCO	4.78443e-05	–0.0169527	0.607162	0.695667
SER	–0.0166992 **	–0.0578144***	–1.67975 **	–1.92001**
RSU	–0.0476138 ***	–0.137883***	–4.19387 ***	–4.08119***
Royp	–1.15779	–5.10558*	–217.805 *	–321.820**
Royse	–3.75789	5.69166	–1178.21 **	–2201.18***
Normality of residuals (p-value)	0.0451827	0.00209865	1.46387e-008	2.32324e-020
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

TABLE 21 RESULTS OF TOBIT PANEL: MUNICIPAL SPENDING PER SUBFUNCTION

Dependent variables	Gini	Theil	P10-40	P20-20
Constant	0.568551	0.637489***	20.3360***	22.6502***
Primary health care/GDP	–2.64721***	–7.51349***	–259.741***	–339.604***
Hospital care/GDP	–2.28462***	–4.22348**	–259.639***	–330.704***
Prophylactic support/GDP	11.5342	28.9900	1472.53*	1841.02*
Health surveillance/GDP	1.90910	–12.2808	124.615	598.247
Epidemiological surveillance/ GDP	11.2041	30.1665	1068.96	1591.86*
Food and Nutrition/GDP	–18.9902	–20.9494	–2217.12	–3267.36
Other expenditures on health/GDP	–5.10658***	–12.4331***	–522.942**	–553.692***
Primary education/GDP	0.930039***	3.04759	74.5875**	108.175**
Secondary education/GDP	–21.4922**	–59.6665**	–2462.66**	–2286.71*
Professional education/GDP	7.57272	20.2995	1023.64	2261.00*
Higher education/GDP	20.2427***	74.3591***	2126.51***	2333.01**
Early childhood education/GDP	–4.42682***	–8.27138**	–423.490***	–660.402***
Adults' and young adults' education/ GDP	9.65578	18.5396	858.914	854.450
Special education/GDP	33.8695*	94.8688	1630.00	720.818
Other expenditures on education/GDP	1.32658	4.65999	108.375	261.330*

Continue

Dependent variables	Gini	Theil	P10-40	P20-20
RNE	0.0539289***	0.167720***	5.72410***	5.49636***
RCO	0.0143536***	0.0398145**	1.71563***	1.93881***
SER	0.00634491	0.0139220	0.315911	0.281851
RSU	–0.0241827***	–0.0559703***	–2.11089***	–1.41746*
Royp	–1.58276*	–6.37447**	–260.231***	–343.131***
Royse	–2.06360	–1.98847	–755.960*	–1613.09***
Normality of residuals (p-value)	0.000890747	0.00387232	0.000696878	1.23774e-006
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

TABLE 22 RESULTS OF TOBIT PANEL: STATE AND MUNICIPAL SPENDING PER SUBFUNCTION

Variables	Gini	Theil	P10-40	P20-20
Constant	0.577192***	0.681616***	20.8104***	23.0597***
Primary health care/GDP	–2.33303***	–5.18519***	–239.056***	–275.405***
Hospital care/GDP	–0.454295**	–1.20768**	–42.2232**	–46.6353*
Prophylactic support/GDP	–4.54344***	–15.6384***	–547.696***	–625.134***
Health surveillance/GDP	7.47420***	14.3278 ***	839.856***	923.082***
Epidemiological surveillance/ GDP	4.22954	12.0382	436.318	955.297
Food and Nutrition/GDP	26.2222***	69.1208 ***	2341.81***	2507.62 ***
Other expenditures on health/GDP	–1.44270***	–3.66453***	–125.969***	–128.061***
Primary education/GDP	0.307757**	0.977099**	19.2904	23.1947
Secondary education/GDP	0.0108081	–2.18808*	13.7298	92.9031
Professional education/GDP	3.74522	–2.39010	591.555*	848.798**
Higher education/GDP	–1.57718	–2.18501	–109.773	–132.647
Early childhood education/GDP	–3.09121***	–3.13597	–341.570***	–540.151***
Adults' and young adults' education/ GDP	–4.34205	–14.2754	–586.660	–914.466**
Special education/GDP	5.02294	11.5390	559.183	381.283
Other expenditures on education/GDP	0.370787**	1.48305***	32.2939*	29.1974
RNE	0.0444438***	0.151092***	4.60189***	4.33877***
RCO	0.00575048	0.0042261	1.04007	1.24385
SER	–0.0127104**	–0.0398646**	–1.53920**	–1.67672**
RSU	–0.0361492***	–0.107477 ***	–3.11454***	–2.51459***
Royp	–0.223412	–3.35553	–98.0106	–157.092
Royse	2.23620	15.5157	–449.241	–1244.60**
Normality of residuals (p-value)	0.027971	0.000222199	3.22292e-00	3.22225e-016
Number of States	27	27	27	27
Number of observations	486	486	486	486

Source: Elaborated by the authors.
Note: ***Significant to 1%; **Significant to 5%; *Significant to 10%.

Observing the broken down spending on health, tables 20, 21 and 22 showed the subfunctions that contributed to reduce income inequality between 1995 and 2012: primary health care, hospital and outpatient care, prophylactic and therapeutic support and other expenditures with health.

Considering that the broken down spending on education, even though there was no agreement between the results presented in the 03 previous tables, the spending on Early childhood education was more significant to reduce income inequality.

5. FINAL CONSIDERATIONS

Income inequality is a social phenomenon that justifies State intervention in the economy. However, it is necessary that decision makers in the government are able to identify which interventions actually can or should come into effect for reducing income inequality.

This study sought to identify the effects of the allocation function on income inequality. The design of the research considered the effects of spending on education and health, meritorious goods representing the allocation function; the differences between Brazil's five regions; and the differences between States and municipalities that receive income from oil and electricity sector royalties.

The contribution of this study is to attempt to identify public spending that can in fact influence reducing income inequality. Therefore, the research focused on a database with an extensive period from 1995 to 2012, a period of relative economic stability. Another important point is that, in order to give greater consistency to the findings, four different dependent variables that capture income inequality were included: the Gini coefficient, the Theil coefficient, the ratio between the richest 10% and poorest 40%, and the ratio between the richest 20% and poorest 20%.

After the application of the tests, it was concluded that States and municipalities that have invested proportionately more in health in relation to the GDP managed to reduce inequality in a greater proportion, with the opposite effect when it comes to spending on education.

Observing this controversial result and considering previous studies, there was a need to break down the proportion of spending on education in subfunctions of the existing spending in the country. In this second phase of the study, it was found that spending on early childhood education helped in reducing income inequality.

The results obtained in this study showed that, in the case of education, only the spending on the variable early childhood education proved to influence inversely and significantly the indicators of income inequality. This hinders the hypothesis assumption that suggests that all spending on health and on education, aggregated or disaggregated, were related inversely and significantly to indicators of income inequality, showing that the current model empirically does not fulfill its role.

This study has limitations that were presented in the theoretical framework. However, its findings allow suggesting for future research the inclusion of the other budgetary functions, i.e., distribution and stabilization, as well as their respective impact on income inequality.

REFERENCES

ARAÚJO, Jevuks M.; ALVES, Janielle A.; BESARRIA, Cássio N. O impacto dos gastos sociais sobre os indicadores de desigualdade e pobreza nos estados brasileiros no período de 2004 a 2009. *Rev. Econ. Contemp.*, Rio de Janeiro, v. 17, n. 2, p. 249-275, May/Aug. 2013.

BALTAGI, B. H. *Econometric analysis of panel data*. 3. ed. New York: Wiley, 2005.

BASSETT, William F.; BURKETT, John; PUTTERMAN, Louis. Income distribution, government transfers, and the problem of unequal influence. *European Journal of Political Economy*, v. 15, p. 207-228, 1999.

BERGH, Andreas; FINK, Gunter. Higher education policy, enrollment, and income inequality. *Social Science Quarterly*, v. 89, n. 1, p. 217-235, 2008.

BRAZIL. Constituição da República Federativa do Brasil. *Diário Oficial [da] República Federativa do Brasil*, Poder Legislativo, Brasília, DF, 5 Oct. 1988.

BRAZIL. Lei nº 13.242 de 30 de dezembro de 2015. Dispõe sobre as diretrizes para a elaboração e execução da Lei Orçamentária de 2016 e dá outras providências. *Diário Oficial [da] República Federativa do Brasil*, Poder Executivo, Brasília, DF, 31 Dec. 2015.

BRUE, Stanley L. *História do pensamento econômico*. 6. ed. São Paulo: Thomson Learning, 2005.

CARVALHO, Fernando J. C. Equilíbrio fiscal e política econômica keynesiana. *Revista Análise Econômica*, v. 26, n. 50, p. 7-26, 2008.

CASTRONOVA, Edward. Inequality and income: the mediating effects of social spending and risk. *Economics of Transition*, v. 9, n. 2, p. 395-415, 2001.

COWELL, Frank A. *Measuring inequality*. 3. ed. Oxford: Oxford University Press, 2011.

DATASUS. Informações de Saúde (Tabnet). 2015. Available at: <www2.datasus.gov.br/DATASUS/index.php?area=0205>. Accessed on: 18 May 2015.

EASTERLY, William; REBELO, Sergio. Fiscal policy and economic growth: an empirical investigation. *Journal of Monetary Economics*, v. 32, 417-458, 1993.

FIGINI, Paolo. *Inequality and growth revisited*. Dublin, Ireland: Trinity College Press, 1998.

GIACOMONI, James. *Orçamento público*. 16. ed. São Paulo: Atlas, 2012.

GOUVEIA, Miguel; MASIA, Neal A. Does the median voter explain the size of government? Evidence from the states. *Public Choice*, v. 97, n. 1, p. 159-177, 1998.

HOLZNER, Mario. Inequality, growth and public spending in Central, East and Southeast Europe. *The Vienna Institute for Internacional Economic Studies*, Working Papers, v. 71, 2010.

IBGE. Instituto de Brasileiro de Geografia e Estatística. *Sistema de contas nacionais*. 2015. Available at: <www.ibge.gov.br/home/estatistica/pesquisas/pesquisa_resultados.php?id_pesquisa=48>. Accessed on: 16 May 2015.

IPEA. Instituto de Pesquisa Econômica Aplicada. *Ipeadata*. 2015. Available at: <www.ipeadata.gov.br/>. Accessed on: 4 May 2015.

JHA, Raghbendra; BISWAL, Bagala; BISWAL, Urvashi D. An empirical analysis of the impact of public expenditures on education and health on poverty in Indian states. *Queen's Institute for Economic Research*, Discussion Paper, v. 998, 2001.

KEYNES, John. M. *A teoria geral do emprego, do juro e da moeda*. São Paulo: Nova Cultural, 1996.

KUZNETS, Simon. Economic growth and income inequality. *American Economic Review*, v. 45, n. 1, p.1-28, 1995.

LIMA, Gabrielle P. P.; MOREIRA, Tito B. S.; SOUZA, Geraldo S. Eficiência dos gastos públicos no Brasil: análise dos determinantes da pobreza. *Economia e Desenvolvimento*, v. 12, n. 2, p. 28-61, 2013.

LINDERT, Peter H. What limits social spending? *Explorations in Economic History*, v. 33, n. 1, p. 1-34, 1996.

LUNDBERG, Mattias; SQUIRE, Lyn. The simultaneous evolution of growth and inequality. *The Economic Journal*, v. 113, n. 1, p. 326-344, 2003.

MELLO, Luiz; TIONGSON, Erwin R. Income inequality and redistributive government spending. *Public Finance Review*, v. 34, n. 3, p. 282-305, 2006.

MELTZER, Allan H.; RICHARD, Scott F. Tests of a rational theory of the size of government. *Public Choice*, v. 41, n. 3, p. 403-418, 1983.

MILANOVIC, Branko. Do more unequal countries redistribute more? Does the median voter hypothesis hold? *European Journal of Political Economy*, v. 16, n. 1, p. 367-410, 2000.

MUSGRAVE, Richard A.; MUSGRAVE, Peggy B. *Finanças públicas*: teoria e prática. Rio de Janeiro: Campus, 1980.

OBJETIVOS DE DESENVOLVIMENTO DO MILÊNIO - ODM: *Relatório nacional de acompanhamento.* Coordenação do Instituto de Pesquisa Econômica Aplicada e da Secretaria de Planejamento e Investimentos Estratégicos; supervisão do Grupo Técnico para o acompanhamento dos ODM. Brasília: Ipea; MP; SPI, 2014.

ONU. Organização das Nações Unidas. *Declaração do milênio*. Nova York, 6 a 8 de setembro de 2000. Available at: <www.pnud.org.br/Docs/declaracao_do_milenio.pdf>. Accessed on: 4 May 2015.

PAES, Nelson L.; SIQUEIRA, Marcelo L. Desenvolvimento regional e federalismo fiscal no Brasil: em busca da igualdade na distribuição de receitas. *Economia Aplicada*, v. 12, n. 4, p. 707-742, Oct./Dec. 2008.

PANIZZA, Ugo. Income inequality and economic growth: evidence from American data. *Journal of Economic Growth,* v. 7. n. 1, p. 25-41, 2002.

PARTRIDGE, Mark. D. Is inequality harmful for growth? Comment. *American Economic Review*, v. 87, n. 5, p. 1019-1032, 1997.

PEROTTI, Roberto. Growth, income distribution, and democracy: what the data say. *Journal of Economic Growth*, v. 1, n. 2, p. 149-187, 1996.

PEROTTI, Roberto. Income distribution, politics, and growth. *The American Economic Review*, v. 82, n. 2, p. 311-316, 1992.

PERSSON, Torsten; TABELLINI, Guido. Is inequality harmful for growth? Theory and evidence. *American Economic Review*, v. 84, n. 3, p. 600-621, 1994.

REZENDE, Fernando. *Finanças públicas*. 2. ed. São Paulo: Atlas, 2001.

RODRIGUEZ, Francisco R. Does distributional skewness lead to redistribution? Evidence from the United States? *Economics and Politics*, v. 11, n. 2, p. 171-199, 1999.

SCALON, Celi. Desigualdade, pobreza e políticas públicas: notas para um debate. *Contemporânea*, v. 1, n. 1, p. 49-68, 2011.

SRFB. Secretaria da Receita Federal. *Arrecadação*. Available at: <http://idg.receita.fazenda.gov.br/dados/receitadata>. Accessed on: 4 May 2015.

SOUSA, Maria C. S.; CRIBARI-NETO, Francisco; STOSIC, Borko D. Explaining DEA technical efficiency scores in an outlier corrected environment: the case of public services in Brazilian municipalities. *Brazilian Review of Econometrics*, v. 5, n. 2, p. 287-313, 2005.

STE. Secretaria do Tesouro Nacional. *Contas nacionais*. Available at: <hwww.tesouro.fazenda.gov.br/pt/contas-anuais>. Accessed on: 4 May 2015.

SYLWESTER, Kevin. Can education expenditures reduce income inequality? *Economics of Education Review*, v. 21, n. 1, p. 43-52, 2002.

TANNINEN, Hannu. Income inequality, government expenditures, and growth. *Applied Economics*, v. 31, n. 1, p. 1109-1117, 1999.

TORRES, Rafael L. Licitações sustentáveis: sua importância e seu amparo constitucional e legal. *Interesse Público — IP*, Belo Horizonte, v. 14, n. 71, p. 219-241, Jan./Feb. 2012.

ZHANG, Lei. Political economy of income distribution dynamics. *Journal of Development Economics*, v. 87, n. 1, p. 119-139, 2008.

Giovanni Pacelli Carvalho Lustosa da Costa
Holds a doctorate in Accounting Sciences (UnB), is federal auditor of finance and control, general coordinator of planning and evaluation of the Ministry of Transparency, Inspection and Comptroller General of Brazil. E-mail: giovanni.costa@cgu.gov.br.

Ivan Ricardo Gartner
Holds a doctorate in Production Engineering (UFSC), post-doctorate in Administration (FEA-USP), post-doctorate in Operational Research (FernUni Hagen). Professor at the Department of Administration of the University of Brasilia (UnB). E-mail: irgartner@hotmail.com.