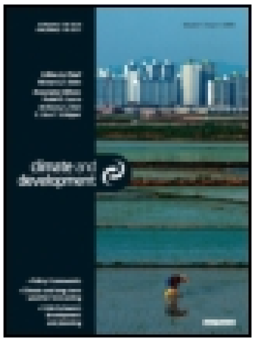

Taylor & Francis
Taylor & Francis Group

Climate and Development

ISSN: 1756-5529 (Print) 1756-5537 (Online) Journal homepage: http://www.tandfonline.com/loi/tcld20

Impacts of carbon pricing on income inequality in Brazil

Carolina Grottera, Amaro Olimpio Pereira Jr & Emilio Lèbre La Rovere

To cite this article: Carolina Grottera, Amaro Olimpio Pereira Jr & Emilio Lèbre La Rovere (2015): Impacts of carbon pricing on income inequality in Brazil, Climate and Development, DOI: 10.1080/17565529.2015.1067183

To link to this article: http://dx.doi.org/10.1080/17565529.2015.1067183

Published online: 23 Sep 2015.

Climate and Development, 2015
http://dx.doi.org/10.1080/17565529.2015.1067183

RESEARCH ARTICLE

Impacts of carbon pricing on income inequality in Brazil

Carolina Grottera*, Amaro Olimpio Pereira Jr and Emilio Lèbre La Rovere

CentroClima/PPE/COPPE, Centro de Tecnologia, Federal University of Rio de Janeiro, Bloco C, Sala 211 Cidade Universitaria 21941-972 – Ilha do Fundão, Rio de Janeiro, RJ, Brazil

(*Received 1 October 2014; final version received 13 March 2015*)

The introduction of a tax on greenhouse gases aims to increase awareness of the real costs of economic activities across all stakeholders. In the absence of such tax, these activities generate negative externalities, a market failure that imposes costs on others, including future generations. Developing countries have increasingly contributed to climate change, and emission mitigation policies are therefore also required in these economies. Among the priorities in their political agendas, however, are to reduce income concentration and alleviate poverty. Climate policies should therefore be implemented without interfering with such social goals. This study uses a Social Accounting Matrix for Brazil in 2005 to analyse the impact of implementing a charge per tonne of CO_2e emitted on income distribution in Brazil. The results differ as much in relation to the level of the applied tax as to the means whereby the revenue thus raised is recycled in the economy. Two option paths are simulated: direct transfer to low-income families and exemption from labour taxes. As complementary results, impacts on GDP, on employment levels, and on GHG emissions are also analysed.

Keywords: climate change; mitigation; Latin America; economics

1. Introduction

Developing countries already contribute significantly to growing GHG emissions and, given their patterns of economic and demographic growth, the trend is worsening. Mundaca, Markandya, and Nørgaard (2013) show that, except for African countries, most developing economies have performed worse than their historical trends in terms of GHG emissions in recent years. Improvements in energy intensities and decarbonization policies were not sufficient to offset the effects of economic growth and increased energy use. In Latin America, this pattern resulted in greater carbon and energy intensities.

These countries have experienced increasing pressures to commit to efforts to reduce GHG emissions (González, 2012; Timilsina & Shrestha, 2002) and came to join forces in their mitigation efforts (Hällding, Jürisoo, Carson, & Atteridge, 2013).

The reduction of GHG emissions in developing countries involves distinct peculiarities. In addition to the commitment to economic activity and competitiveness (see Aldy & Pizer, 2009; Heil & Selden, 2001), issues arise related to the reduction of income inequality and poverty eradication, priority goals in the political agendas of these countries.

González (2012) emphasizes that the different impacts which environmental policies can generate on income classes deserve to be treated with special attention, since the lower income classes tend to live in extreme poverty. It is estimated that the worst effects of climate change will fall precisely on the poor, since they are the most vulnerable to extreme weather events and have the least capacity to adapt to extreme weather events. Moreover, many of these countries depend on agricultural activities, whose productivity can be severely jeopardized.

In the case of Brazil, it would be interesting to curb the effects of climate change for several reasons. The biodiversity of the Amazon biome is shown to be irreversibly imperiled in the most extreme global-warming scenarios. Moreover, it is estimated that the most severe impacts will be in the North and Northeast regions, precisely the poorest in the country, contributing to the worsening of social disparities (Margulis, Dubeux, & Marcovitch, 2010).

In 2009, during the 15th Conference of the Parties to the United Nations (COP-15), Brazil announced its voluntary commitment to reducing its GHG emissions, reinforced by the National Policy on Climate Change (PNMC[1]) (Gurgel & Paltsev, 2014; La Rovere, Pereira, Dubeux, & Wills, 2014), indicating a continuing

*Corresponding author. Email: carolinagrottera@ppe.ufrj.br

reorientation of geopolitics affecting Climate Change negotiations (Coetzee & Winkler, 2014).

Efforts to mitigate GHG emissions should not, however, be given priority over the goal of improving the living conditions of the population. Brazil is among the countries that have the highest levels of income concentration. In 2006, the share of total income appropriated by the richest 1% portion of the population was equal to that received by the poorest 50% (Barros, Foguel, & Ulyssea, 2006).

Nevertheless, Brazil has experienced a continuous and accelerating fall in levels of income concentration, due mainly to increased government transfers to families, through social programmes such as *Bolsa Familia* and real increases in pensions and retirement benefits.

As the efforts to mitigate GHG emissions in Brazil take shape, so does the debate over their effect on income distribution in the country. The process still needs careful analysis, since harmonization of the objectives of both policies is highly desirable.

With this in mind, it is the aim of this work to develop a framework that allows the assessment of the impact of an environmental tax reform on Brazilian income distribution. A complementary analysis will examine the effect on the level of output, employment and GHG emissions.

The introduction of a carbon tax on emissions from productive sectors of the economy is simulated. The income earned by the measure can be recycled in various ways, such as by direct transfer to lower income class families or via exemption from labour taxes.

The chosen methodology involves the development of a Social Accounting Matrix (SAM) for Brazil with 2005 as the base year. The choice of this base year is justified by the availability of data regarding both the National Accounts and GHG emissions for Brazil. In addition to productive sectors, income classes, productive factors, other entities and the capital accumulation and savings account, the matrix is further enhanced with the total of GHG emissions for each sector (Brasil, 2010; La Rovere, Dubeux, Pereira, & Wills, 2013), as outlined in Miller and Blair (2009).

The hypothesis tested is that inequality levels, GDP, employment and emissions are all affected, though in distinct forms, both by the level of the carbon tax and by the method of reinsertion of the revenues into the economy.

Section 2 presents a general framework of carbon taxes as a way to mitigate GHG emissions. Section 3 presents the fundamentals of the input–output analysis and the means by which the model was constructed for this study, including the breakdown of households by income. Section 4 describes the simulations and Section 5 presents and discusses the main results and the model limitations. Finally, Section 6 presents the conclusions of the study.

2. Carbon taxes and their distributional effects in developing countries

Carbon taxes are a fixed price to be paid for a certain amount of CO_2, or CO_2e, emitted due to anthropogenic activities (Rich, 2004). The purpose of a carbon tax is to internalize the externalities associated with climate change caused by anthropogenic activities. In the absence of such a tax, individuals are faced with price distortions. This happens because economic activities emitting GHGs are relatively inexpensive, since they do not take into account the costs imposed on others, including future generations (Bithas, 2011). The implementation of a carbon tax may lead individuals to fully consider the consequences of GHG emissions (Metcalf & Weisbach, 2009).[2] Compared to other market-based instruments applicable to GHG emissions, such as emissions trading schemes, carbon taxes entail lower transaction costs (Joas & Flachsland, 2014; Mundaca, Mansoz, Neij, & Timilsina, 2013).

Since lower income group families generally spend a higher proportion of their income on energy and natural resources than higher income class families, the implementation of a carbon tax usually burdens the former more than the latter (Baranzini, 1997; Baranzini, Goldemberg, & Speck, 2000; Callan, Lyons, Scott, Tol, & Verde, 2009). This regressive character presented by carbon taxes is expected mainly in developed countries, for which literature on the distributional effects of carbon taxes is somewhat consolidated (Cornwell & Creedy, 1996; Klinge Jacobsen, Birr-Pedersen, & Wier, 2003; Wier, Birr-Pedersen, Jacobsen, & Klok, 2005). Nonetheless, Dissou and Siddiqui (2014) argue that most of these analyses do not fully consider the channels through which carbon taxes affect distribution. They show that polluting industries tend to be capital intensive and that the rich derive most of their income from capital; hence, carbon taxes may improve income distribution by burdening upper income classes through the income channel.

However, results found in these studies cannot be easily replicated in developing countries, for which research is still incipient. There are considerable differences with regard to the means of transport used, heating, industrial goods consumed and the use of biofuels (Brenner, Riddle, & Boyce, 2007). In Brazil there is additionally the magnitude of the informal sector and the amount of emissions from agriculture and land use in general. For a brief overview of the impact of carbon taxation on income distribution in developing countries, see Brenner et al. (2007), González (2012), Timilsina and Shrestha (2002), Chen, Timilsina, and Landis (2013), Van Heerden, Gerlagh, Blignaut, and Horridge (2006), Fisher-Vanden, Shukla, Edmonds, Kim, and Pitcher (1997), Shah and Larsen (1992) and Jensen and Tarr (2002). It is possible to avoid the negative effects of carbon taxation through some alternatives. Reducing or exempting the rate for vulnerable groups, as already occurs with other taxes such as on electricity, or compensating them includes some options. Another alternative would be to impose the tax only after a certain level, ensuring that the resources required to meet the basic needs of the population remain exempt from taxation (Baranzini et al., 2000; Speck, 1999).[3]

The income earned through the tax could also be used to mitigate the undesirable effects. The way the tax revenue is recycled in the economy determines whether its effect will be regressive, progressive or neutral (Fullerton & Heutel, 2007; González, 2012; Metcalf, 2009; West & Williams, 2004).

Some of the options for using the revenue earned from carbon taxes include its allocation to the relief of existing and naturally distorting taxes on labour and on income, or for the improvement of the social security system (Speck, 1999). Baranzini et al. (2000) point out that this type of measure has a peculiarity in developing countries. Since the poorest sectors of the population, due to the magnitude of the informal sector, are often not included in institutional, legal and tax systems, they may well fail to be included in compensation programmes.

Another form of recycling, often found in the literature, is in the form of government transfers to households, as proposed in Timilsina and Shrestha (2002). The revenue collected from the tax is directly distributed to the population, allocated either following certain criteria or equally to all. Poorer class families would receive an amount proportionately larger to their income than higher income class families.

This type of option makes clear the existence of the possibility of the so-called double dividend: environmental policies generate revenues that can be used to cover expenses previously funded from other sources. They make it possible to transfer the encumbrance away from positive factors, such as capital and labour, and onto undesirable factors, in this case pollution and depletion of natural resources (Baranzini et al., 2000; Seroa da Motta, 2006). This allows a more intensive use of such factors as labour and capital, thereby generating improvements in such aspects as levels of output and employment.

Hourcade (1996 in Baranzini et al., 2000) registers the possibility of an environmental double dividend: the reduction of GHG emissions can result in a reduction in emissions of local pollutants. Van Heerden et al. (2006) and Winkler and Marquard (2011) already suggest the possibility of obtaining a 'triple dividend ', in which the recycling of the tax contributes to a reduction in the levels of inequality.

3. The SAM

This work uses an input–output framework to assess the effect of carbon taxes on income inequality and other aspects. For an introduction to the generalized input–output theory, see Leontief and Ford (1970), Herendeen (1978) and Miller and Blair (2009). The Brazilian input–output model was developed according to Guilhoto and Sesso filho (2010) using national accounts data (IBGE, 2011).

Since one of the goals of this study is to examine the recycling of the revenue raised by charging for carbon emissions, a more extensive matrix than the Input–Output Matrix (IOM) is required. A SAM was developed for this study to fulfil this role, since it supplements IOM data with Integrated Economic Accounts (CEI[4]) data. This data set provides the income of productive factors (capital, labour and land) and entities (households, government, business and the rest of the world), apart from the capital accumulation account. Many of the information supplied by the CEI are not available in the IOM, since they are not related to the production process. Examples include taxes on income, social transfers, transfers between countries and income on financial assets, such as interest and dividends. For further information on SAMs, see Stone & Brown (1962) and Miller and Blair (2009).

The SAM was developed from the environmental IOM for Brazil in 2005, which was itself based on the aggregation into eight sectors of initial products and sectors of the economy, namely Agriculture and Livestock, Forestry, Energy-Electricity, Energy-Others, Industry, Transportation, Services and Waste. The aim of this aggregation was to allow the reconciliation of national accounts monetary flows with GHG emissions data available in La Rovere et al. (2013) and Brasil (2010).

The 'Agriculture and Livestock' sector includes the products of agriculture and livestock. The 'Forestry' sector covers the products of the timber industry and forestry. The 'Energy-Others' sector includes primary and secondary sources of energy other than electricity, which was treated as a separate sector. The 'Industrial' sector comprises all the activities of the Brazilian industry including mining, manufacturing, process industries, food and beverages, textiles, pulp and paper, and cement and chemicals, among others. The 'Energy-Electricity' sector comprises activities related to the generation, distribution and transmission of electricity in the country. The 'Transportation' sector covers activities related to the transport of passengers and cargo. The 'Services' sector includes all activities related to construction, commerce, rental, education, healthcare and financial services, among others. Finally, the 'Waste' sector encompasses activities related to sewage and urban waste collection and disposal.

The framework is complemented with data for three productive factors (labour, capital and land) and the accounts for enterprises, government, rest of the world and households, which are split into 10 different income classes. Finally, data for the capital accumulation account contain the savings of the various institutional sectors and are treated as flexible residual, as proposed in Lofgren, Harris, and Robinson (2002). Figure 1 depicts the SAM

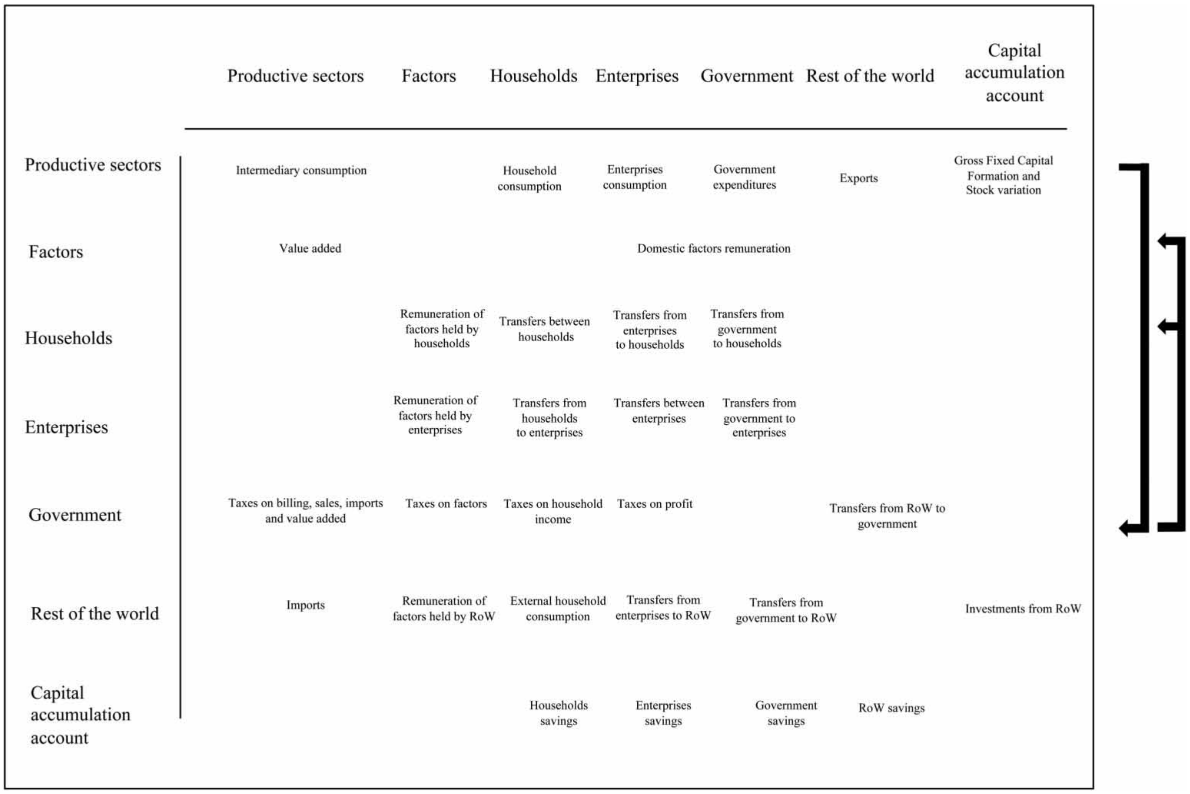

Figure 1. SAM structure.
Source: The authors.

elements for the Brazilian economy. The complete SAM with real values used in the model can be found in Annex I.

The underlying principle of double-entry accounting requires that, for each account in the SAM, total revenue equals total expenditure (Lofgren et al., 2002). In that sense, this framework allows the simulation of public policies from transferring income between agents. For example, the government collects taxes from productive sectors that may in turn be used as a lump sum transfer to households, as shown by the arrows in Figure 1. The impacts of this kind of policy are captured by the input–output multipliers.

3.1. *The breakdown of households by income groups*

To analyse the impact of environmental policies on income distribution, a finer detailing of the household sector is required. To this aim, information was drawn from the Household Budget Survey (POF[5]) 2002–2003 (IBGE, 2004), which allows the breakdown of this sector into 10 different income brackets.

Income groups are determined starting from the number of minimum wages[6] received by the consumption unit, with the lowest income class receiving from 0 to 2 minimum wages, and the highest more than 30 minimum wages. The breakdown was achieved by determining, for the final demand items, the share of total expenditure or income each income class accounts for in percentage terms.[7]

POF 2002–2003 domestic expenditure and food acquisition tables were used to break down the expenditures of households on goods and services, taxes, transfers and social contributions. Household income from labour, capital and transfers was likewise broken down with the aid of the POF 2002–2003 income table.

The difference between total income and total expenditure shows that the only classes whose income exceeded expenditure were the three highest placed in the income table.[8] The total savings of SAM households was therefore apportioned so that the seven lower income-level classes should present negative savings and the three highest income-level classes should present positive savings.

4. Carbon tax impacts

4.1. *Analysis of total GHG emissions in economic activities*

The SAM developed for Brazil in 2005 was updated in accordance with data extracted from La Rovere et al. (2013) and Brasil (2010) (Table 1) to show the estimated total GHG emissions for the eight productive sectors of the Brazilian economy.

Table 1. GHG emissions estimated for the productive sectors of the Brazilian economy in 2005.

Activity sector	Emissions (in $MtCO_2e$)
Agriculture and livestock	431
Forestry	1329
Energy – others	42
Energy – electricity	28
Industrial	157
Transportation	135
Services	13
Waste	41

Source: The authors, based on La Rovere et al. (2013) and Brasil (2010).

The calculation of the direct and indirect emission requirements for the productive sectors of the economy, which arose from the environmental 2005 IOM for Brazil, enables the checking of the emissions profile associated with each activity (Figure 2).

The 'Agriculture and Livestock' sector has a high level of direct requirements, especially related to the use of land for grazing and agriculture, methane emission by livestock and fertilizer use, well above the indirect requirements, linked to energy use in these activities.

The 'Industrial' sector, in turn, has a low level of direct requirements, and a fairly high level of indirect requirements. These results are partially related to the fact that this sector comprises the transformation, manufacturing, and food-processing industries, among others, all responsible for indirect emissions. Moreover, the sector also includes industrial polluting activities such as cement production, which contributes to the direct requirements of the sector.

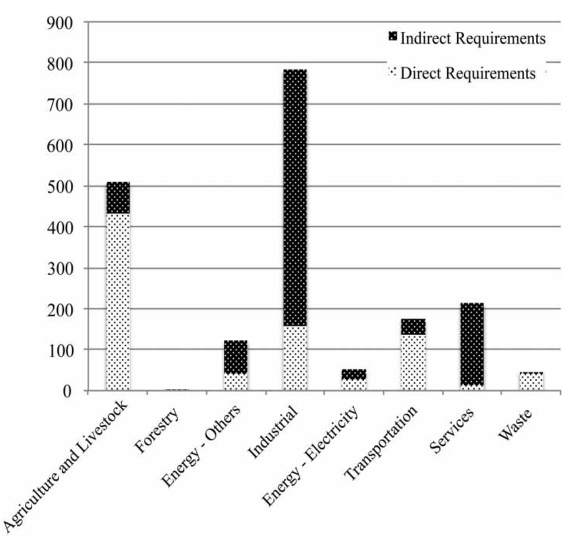

Figure 2. Emissions profile – direct and indirect carbon requirements per sector ($MtCO_2e$).
Source: The authors.

As the Brazilian energy matrix is primarily composed of renewable energy from hydropower, the requirements, both direct and indirect, of the 'Energy-Electricity' sector are very low.

The 'Services' sector essentially uses inputs from other sectors to generate output, having therefore a high degree of indirect requirements, but requiring virtually no direct emissions in its activities.

Direct emissions related to the 'Forestry' sector were 1329 $MtCO_2e$. However, these derive essentially from illegal activities that require specific command-and-control policies to mitigate emissions.[9] These emissions were therefore considered nil in the environmental IOM. The 'Forestry' sector has therefore only been burdened with its indirect emissions, which are minor.

The carbon intensity of the sectors corresponds to the CO_2e content embedded in one monetary unit of the product of each sector. Its calculation provides interesting results, because the coefficient varies widely for different sectors and gives an indication of how much these would be taxed should a charge per tonne of CO_2e emitted be implemented.

The 'Agriculture and Livestock' and 'Waste' sectors are those with the highest carbon intensities and at levels much higher than observed in other sectors. This is due to the fact that these activities, apart from being highly polluting, have low Value Added. The opposite occurs with the 'Services' sector, which, despite having considerable emissions requirements, presents high Value Added, which contributes to reduce its coefficient.

4.2. *Simulation of the carbon tax and revenue recycling*

The imposition of a tax per tonne of CO_2e emitted by productive sectors was simulated using the SAM developed for Brazil in 2005. The rates used were R$25 per tonne of CO_2e emitted and R$50 per tonne of CO_2e emitted.[10]

It should be noted that the emissions attributed to the 'Forestry' productive sector are mostly the result of illicit activities related to deforestation. The collection of payment for the tonne of CO_2e emitted would, in this case, be inoperative since both monitoring and verification are *a priori* compromised. It is assumed that in the case of illegal deforestation, the reduction of emissions should be sought through the use of command-and-control mechanisms designed to ensure the applicability of standards. For this reason, it was decided not to charge the direct emissions related to this sector.

The multiplier model used, extracted from Tourinho, Napoleão, and Alves (2006), is described below.

Let t be the carbon tax (R$/t$CO_2e$) applied to the productive sectors and C be the amount of CO_2e (Mt) emitted by each productive sector. The expression $T_j = t*C_j$ determines by how much each sector should be charged according to the tax per tonne of carbon emitted. The sum $\sum T_j$ represents the total tax collected by the government in millions.

However, it was decided to rate the activities not in accordance with their direct GHG emissions, but in terms of total GHG emissions, that is, direct and indirect.

Let R_j be the total requirements of GHG emissions of the production sector j.

$r_j = R_j / \sum R_j$ corresponds to the proportion of the total requirements of the economy attributed to sector i.

This coefficient is used to weight how each sector should effectively pay for their emissions, that is,

$$T'_j = r_j * T_j. \tag{7}$$

It is noted that $\sum T_j = \sum T'_j$.

The ratio T'_j / Y_j represents the proportion of the amount paid by sector j relative to its total production.

The expression $E_j = [1 - (T'_j / Y_j)]$ determines the reduction in the total output of production sector j due to the imposition of the carbon tax. There is thus a column vector (8×1) E, containing all the coefficients E_j, which is used to pre-multiply the technical coefficients matrix (A_n), which affects directly the interdependency coefficients matrix (Ma). This procedure generates a new level of final demand and consequently of total production.

The difference between the new total output (Y_t) and the total original output (Y) determines how much each variable is affected by the imposition of the tax on emissions. Since it is intended to simulate an increase in taxes and, therefore, on the total output of the economy, this value can be added to the original production.[11]

4.3. *Impact of carbon tax on the value added, employment, GHG emissions and income inequality*

As described in the previous section, the imposition of a carbon tax alters the An matrix and consequently the Ma matrix, which becomes Ma_{ij}.

Let VA_j be the Value Added of sector j, Y_{jf} the value of the total output of industry j after applying the tax and Ma_{ij}' the transposition of matrix Ma_{ij}; $m(h)_{ij} = \text{VA}_j / Y_{jf} * \text{Ma}_{ij}'$ then represents the variation in the Value Added of sector i derived from the taxation of sector j.

The sum $\Sigma\, m(h)_{ij}$ equals the total impact of taxing the value added of sector i.

The same procedure was used to check the impact of the carbon tax on the level of employment (L_j) and on GHG (C_j) emissions. This approach is based on the model described in Zaghini (1971) and Xu, Hong, He, Wang, and Chen (2011), in which the authors advocate that a change in the value added affects prices; hence, impacts can be assessed from this perspective.

As can be seen in Figure 1, a SAM framework allows the simulation of transferring income from one sector or entity to others. In this sense, the revenue accrued with the carbon tax may serve different purposes. Thus, three scenarios for the using the tax revenues were simulated. In the first case, there is no recycling. The government collects the revenue from the tax, but it is not reinserted directly into the economy. It could be used, for example, for reducing public debt, a situation in which the government does not remain fiscally neutral with respect to the tax measure. In the second case, all the revenue from the tax is passed on in the form of direct transfers to the first seven lower income classes, the ones that present negative savings levels in the reference scenario. The amount collected is added directly to the final demand of each class in accordance with the proportion it represents of negative savings in the base case. In the third case, the revenue collected is used to relieve taxation on the labour factor. In this case, the sum increments the labour factor total output, increasing the wage levels received by households. The variable chosen to measure the impacts of mitigation policies on income inequality was the Gini coefficient, which varies from 0 to 1. In order to compute it, it is necessary to build a Lorenz Curve, which relates the cumulative share of the population to the cumulative share of the income earned. The area formed by the graph corresponds to the Gini coefficient. A Gini coefficient equal to 1 corresponds to the most unequal distribution possible, whereas a Gini coefficient equal to 0 denotes a situation in which all enjoy the same income level (see Barros et al., 2006; Gini, 1909). As the model provides the welfare variation of each household class (and we already know the corresponding population of each income class), this information was used to build a Lorenz Curve, and thus to calculate the Gini coefficient.

Due to its static character, the model assumes that all the interactions among components of the economy occur at the same time, instead of in a dynamic way (see Davies, 2012). It is possible, hence, that results are slightly overestimated, since a carbon tax may overestimate the decrease in the economic activity. The loss in production will reduce the use of primary factors, which will reduce household income more than expected, since labour and capital can migrate from those highly impacted sectors to other less affected by the carbon tax.

5. Results and discussion

5.1. *Results*

5.1.1. *Carbon tax of R\$25/tCO_2e*

A R\$25 carbon tax has the following impacts on GDP, employment, emissions and Gini coefficient, illustrated in Table 2.[12]

When there is no recycling of revenues, avoided emissions are of 5.94% of the base case level, GDP falls by 3.06% and employment levels by 3.76%. The Gini

Table 2. Results with a R$25 tax rate.

	GDP %	(1/Gini coefficient) %	Employment %	Avoided GHG emissions %
No recycling	−3.06	0.05	−3.76	5.94
Direct transfer to households	−1.54	1.40	−2.38	3.92
Reduction of labour taxes	0.29	−0.13	−1.10	2.96

Source: The authors.

coefficient inverse increases by 0.05%. The imposition of charges for GHG emissions takes effect gradually, thereby helping to reduce income inequality. Similar results appear in Barker and Köler (1998), Ojha (2011) and Brenner et al. (2007). It is noteworthy to stress that this analysis focuses on the distributional effects of the carbon tax: even if all income classes' welfare is impaired, the policy can be progressive, if upper income classes are more adversely affected (see Dissou & Siddiqui, 2014).

When the revenue is transferred directly to households, avoided emissions are of 3.92% only, GDP falls by 1.54% and employment levels by 2.38%. A rebound effect (Greening, Greene, & Difiglio, 2000) is perceived, whereby the recycling-generated increase in the income of one component of the economy brings about an increase in its final demand, which in turn creates a multiplier effect in the economy, offsetting the recessive effect of the taxation. In the case of direct transfer, the effect is caused by the higher level of consumption to which lower income households are given access. This measure is the one which most contributes to the reduction of income inequality in the economy. There is an increase in the Gini coefficient inverse of 1.4%. In this case, a progressive character on the tax can be identified, stemming from the revenue recycling scheme.

Finally, if the revenue is used to reduce fiscal burden on the labour factor, avoided GHG emissions are down to 2.96%, while a co-occurring 0.29% increase in GDP is noted. It is thus observed that there is a double dividend, as indicated by Böhringer and Rutherford (1997), Parry and Bento (2002), Van Heerden et al. (2006) and Alton et al. (2012). There is a reduction of 1.1% in employment levels. In this case, the rebound effect is brought about by a smaller loss of jobs, which in turn generates a greater consumption demand. Both in the case of transfers to households and of the easing of labour charges, the effect gives rise to greater economic activity compared to the no recycling case, with the associated generation of GHG emissions. It is striking to acknowledge that, in this case, GDP increases while employment levels decrease. This may be explained by the level of taxation to which different sectors are subjected. The agriculture sector, for example, which is a very labour-intensive one, is one of the sectors that are burdened the most. The services sector, on the other hand, is the one which is burdened the least. Due to its high Value Added, this contributes to increasing GDP (Figure 3).

The exemption of taxes on labour contributes, however, to effectively increase income inequality in the economy since the Gini coefficient inverse decreases 0.13%. One possible explanation is that many low-income households belong to the informal labour market; hence, they do not benefit directly from this measure (Figure 4).[13]

5.1.2. *Carbon taxation at 50 R$/t$CO_2$e*

When the carbon tax is set at R$50, we obtain the results in Table 3.

A marked recessive effect is observed when the revenue is not reinserted into the economy. There is a reduction of 5.42% in GDP and 6.68% in employment levels. On the other hand, avoided GHG emissions reach the highest level: 10.56%. As in the case of R$25 per tonne emitted, the effect of the measure is progressive: the Gini coefficient decreases.

When the revenue is reinserted into the economy by direct transfer to households, a 6.81% level of avoided emissions is recorded, the lowest observed for all alternatives. Again, this is due to the existence of the rebound effect; GDP and employment are also affected, but not as much as in the case where revenue is not recycled, 2.48% and 4.05%, respectively. This measure helps to considerably reduce income inequality, since the Gini coefficient inverse increases 2.77%.

When the revenue is used to reduce taxes on the labour factor, there is a rebound effect but, unlike the case where the tonne is set at R$25, there is no double dividend. Avoided GHG emissions are at an intermediate level of 7.45%, while GDP and employment fall 9.2% and 3.88%, respectively. This measure, however, contributes to increasing income inequality (Figure 5).

When comparing the results obtained for carbon tax rates of R$25 and R$50, it is seen that as the rate increases, GHG emissions are reduced less than proportionally to GDP and employment level reductions. The decrease in welfare of the agents ceases to be justified by the lower GHG emissions, which leads to the conclusion that the optimal rate would be closer to R$25 than R$50.

Nevertheless, whichever tax is chosen, no measure is absolutely preferable to the others since there are different trade-offs. For example, the direct transfer measure, which most contributes to the reduction of inequality, is the one

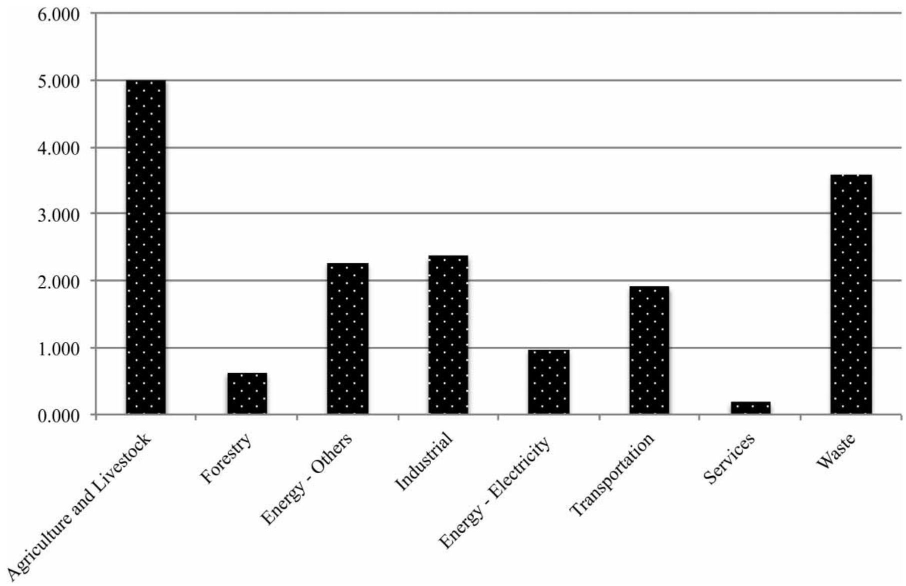

Figure 3. Carbon intensity (in $MtCO_2e$/1000 R$).
Source: The authors.

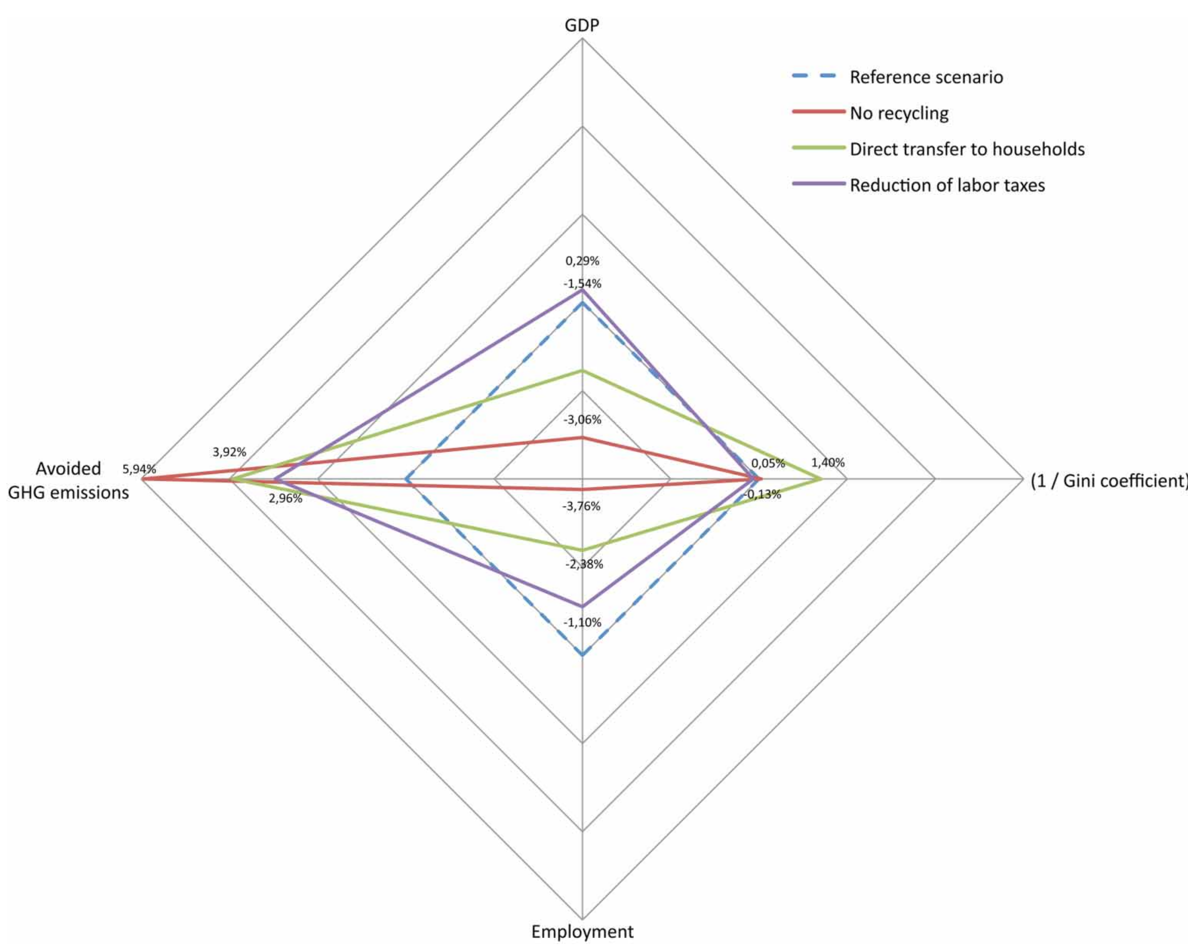

Figure 4. Results – carbon tax rate of R$25/$tCO_2e$.
Source: The authors.

Table 3. Results with a R$50 tax rate.

	GDP %	(1/Gini coefficient) %	Employment %	Avoided GHG emissions %
No recycling	−5.42	0.09	−6.68	10.56
Direct transfer to households	−2.48	2.77	−4.05	6.81
Reduction of labour taxes	−2.09	−0.08	−3.88	7.45

Source: The authors.

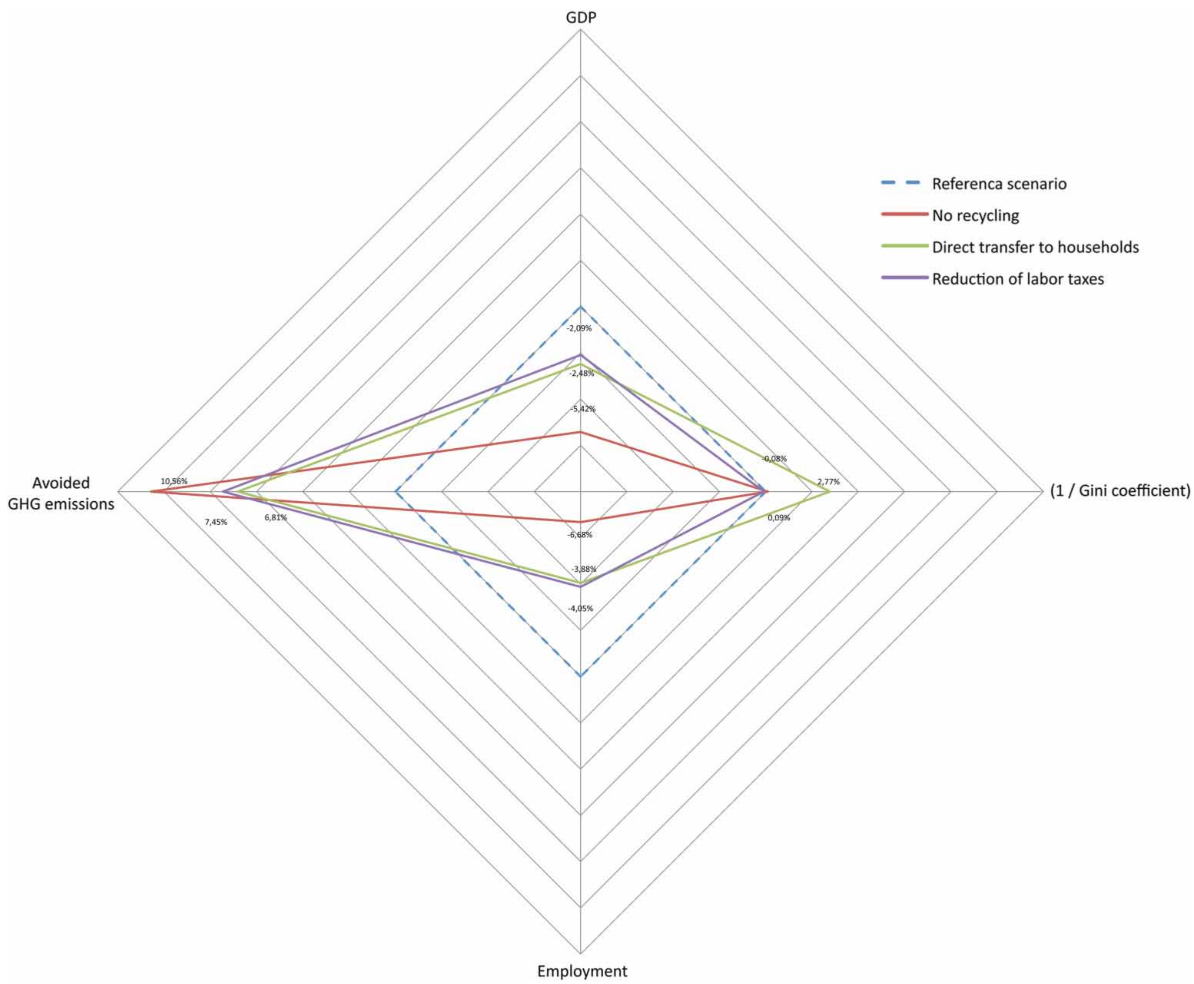

Figure 5. Results – carbon tax rate of R$50/t$CO_2$e.
Source: The authors.

shown to result in the smallest reduction in emissions. On the other hand, labour tax reductions generate a significant reduction in GHG emissions without jeopardizing the GDP and employment levels, and may even produce a double dividend, but effectively increase income inequality. The choice of the best alternative in the use of carbon tax revenues will depend on the priorities held by policy-makers and if the emphasis is on reducing emissions or on socio-economic issues. Brazil, for example, is strongly affirmative regarding policies for reducing inequality. With no binding commitments to mitigate emissions, as are the current circumstances, it is possible that measures that improve income distribution but do not reduce much GHG emissions are chosen over highly mitigating actions.

5.2. *Model limitations*

It should be stressed that the results are a product of a static model that has some limitations. First, as pointed out by Pandey (2002), many difficulties accompany the economic modelling of developing countries and the realistic representation of some of their characteristics. In addition to the great social and regional disparities previously mentioned, these countries generally have a significant informal economy sector, barriers to capital inflows and present considerable regulatory and institutional uncertainties. Given this fact, the model does not take into account emissions from forestry activities that are legal and therefore subject to taxation.

Second, it is important to acknowledge the limitations inherent in the approach chosen, the input–output analysis. Noticeable here is the Leontief function used, which considers constant returns to scale, at the expense of a marginal analysis, and the hypothesis of an inherent homogeneity in the sector-by-sector technology used, often somewhat inconsistent with the reality of some productive activities. Possible constraints to the supply of production factors such as labour and capital are not taken into account,[14] and since it is a static analysis, the model presents stocks at a given period of time, regardless of the wealth accumulated in the past, which compromises the determination of levels of consumption and investment. Finally, the model cannot predict the technological innovations sought by producers when faced with the obligation of paying for their emissions. Nor is it possible to estimate to what extent losses in competitiveness affect the observed results.[15] Finally, it is important to stress that the task performed involves the simulation of a shock in the SAM without it being rebalanced later.

Most of the limitations above mentioned could be overcome with the application of Computable General Equilibrium models (CGE), which are more sophisticated than the framework used in this work. A few CGE models were developed to undertake similar analyses for the Brazilian economy, such as Tourinho, Seroa Da Motta, and Alves (2003), Wills (2013) and Magalhães (2013). Compared to this work, all studies show resembling findings in qualitative terms, especially Wills (2013), since the recycling schemes simulated were similar. Magalhães (2013) is the only model that assesses distributional effects; however, it presents limitations regarding the scenario's projections and technological change assumptions.

Since it is recognized that CGE models are better modelling alternatives, further research on this field includes the assessment of income distribution issues using a CGE framework. Improvements on the IMACLIM-S BR model, developed by Wills (2013), are being undertaken to allow this, similarly to what has been done by Combet (2013).

6. Conclusion

The current study sought to analyse the possible effects of a carbon tax on the concentration of income by means of a static analysis using a SAM for Brazil in 2005. The simulations showed that both the level of the tax and the method whereby the revenue is reinserted in the economy affect the levels of income inequality, with different impacts on GDP, employment levels and GHG emissions.

Based on the results, it is not possible to state that one option is incontestably preferable to the others. However, the analysis helps decision-makers to choose the best option considering their policy priorities. For example, they can choose the policy which brings the best income distribution or the lowest impact in job creation.

The results also showed an inversely proportional and growing relationship between the carbon tax level and GDP, employment, equity and emission levels, bearing in mind that emissions present the greater elasticity with respect to the carbon tax. When the tax revenue is recycled, either by transfer to the lower income classes, or via exemptions of labour charges, the relationship ceases. This indicates that a carbon tax scheme should be followed by a compensation policy that reduces the negative impacts of the tax.

Finally, it is important to note that the level of the tax and the method used to reinsert the revenue into the economy bring about observable changes in GDP and income concentration, apart from milder effects on the reduction of all aggregates, due to the so-called rebound effect.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes

1. Acronym in Portuguese.
2. In addition to carbon taxes, there are other climate policy instruments, such as cap-and-trade, and command-and-control systems of pollution standards, for example. It was felt, however, that carbon taxes are the most appropriate tool for the analysis undertaken in this paper.
3. Baranzini et al. (2000) point to the possible existence of high administrative costs.
4. Acronym in Portuguese.
5. Acronym in Portuguese.
6. The value used is R$200.00 (two hundred Reais), the rate in effect on 15 January 2003, reference date of the research.
7. The calculation was carried out as follows:

$$\mu_{c,i} = (Q_{c,i} * F_c)/\Sigma(Q_{c,i} * F_c), \quad (1)$$

   where $\mu_{c,i}$ represents the share of class c in the total expenditure/income with item i in percentage terms, $Q_{c,i}$ represents the total spent or received by the family in class c with item i, F_c represents the number of families belonging to the class c and Σ ($Q_{c,i}$ * F_c) represents the sum of the total spent or received by all households in the economy with item i.
8. In the 2002–2003 POF, 85.3% of the families with the lowest incomes had, on average, expenditure in excess monthly receipts, and 68.4% with the lowest incomes were already in this situation in 2008–2009. Source: IBGE (2010a, 2010b).
9. There are effective economic policies to combat illegal logging, such as payment for environmental services and agricultural credit policies (see Assunção, Gandour, Rocha, & e Rocha, 2013). However, these policies do not apply to the model used.
10. The average exchange rate between Brazilian Reais and American Dollars in 2005 was R$/US$ 2.44 (Source: IPEA-data, 2014).
11. Although it is possible to simulate what would be the change of the VA_j numerator after applying the carbon tax, it would be difficult to do this for the variables L_j

(employment) and C_j (GHG). For simulation purposes, the Y_{jf} denominator was therefore changed, adding the total amount of tax collected to the total original value.

12. In order to obtain more illustrative results, it was chosen to present the impacts of GHG emissions as 'Avoided GHG emissions' and the impacts on income inequality as the inverse of the Gini coefficient. This way, positive variations in all variables analysed are desirable and negative variations are undesirable.
13. The exoneration of charges on labour helps to create more jobs and reduce levels of informality in the economy, which would benefit the lower income classes and possibly improve the distribution of income in the economy. However, these effects are difficult to obtain in a short-term static analysis.
14. Since these results only include an increase in GDP of 0.29% at the most, this limitation does not in fact undermine the model. It was, however, considered relevant to highlight it.
15. For a more detailed study of the effects of mitigation measures on the competitiveness of Brazilian industry, see Henriques Jr. (2010) and Rathmann (2012).

References

Aldy, J. E., & Pizer, W. A. (2009). The competitiveness impacts of climate change mitigation policies. *Pew Center on Global Climate Change*, 1–41. Retrieved from http://www.c2es.org/docUploads/competitiveness-impacts-report.pdf

Alton, T., Arndt, C., Davies, R., Hartley, F., Makrelov, K., Thurlow, J., & Ubogu, D. (2012). *The economic implications of introducing carbon taxes in South Africa* (WIDER Working Paper). Helsinki: United Nations University.

Assunção, J., Gandour, C., Rocha, R., & e Rocha, R. (2013). *Does credit affect deforestation? Evidence from a rural credit policy in the Brazilian Amazon*. Rio de Janeiro: Climate Policy Initiative.

Baranzini, A. (1997). *International economic instruments and global warming mitigation: An analysis of their acceptability* (Working Paper W54). Geneva: International Academy of the Environment.

Baranzini, A., Goldemberg, J., & Speck, S. (2000). A future for carbon taxes. *Ecological Economics*, *32*, 395–412.

Barker, T., & Köler, J. (1998). Equity and ecotax reform in the EU: Achieving a 10 per cent reduction in CO_2 emissions using excise duties. *Fiscal Studies*, *19*(4), 375–402.

Barros, R. P., Foguel, M. N., & Ulyssea, G. (2006). *Desigualdade de renda no Brasil: uma análise da queda recente – Volume I*. Brasília: Instituto de Pesquisa Econômica Aplicada (IPEA).

Bithas, K. (2011). Sustainability and externalities: Is the internalization of externalities a sufficient condition for sustainability? *Ecological Economics*, *70*, 1703–1706.

Böhringer, C., & Rutherford, T. (1997). Carbon taxes with exemptions in an open economy: A general equilibrium analysis of the german tax initiative. *Journal of Environmental Economics and Management*, *32*, 189–203.

Brasil. (2010). *Segunda Comunicação Nacional. Ministério da Ciência e Tecnologia*. Coordenação-Geral de Mudanças Globais de Clima, 2010. Segunda Comunicação Nacional do Brasil à Convenção-Quadro das Nações Unidas sobre Mudança do Clima, Ministério de Ciência e Tecnologia, Brasília. Retrieved October 2011, from www.mct.gov.br/clima

Brenner, M., Riddle, M., & Boyce, J. K. (2007). A Chinese sky trust? Distributional impacts of carbon charges and revenue recycling in China. *Energy Policy*, *35*, 1771–1784.

Callan, T., Lyons, S., Scott, S., Tol, R. S. J., & Verde, S. (2009). The distributional implications of a carbon tax in Ireland. *Energy Policy*, *37*, 407–412.

Chen, Y. H. H., Timilsina, G. R., & Landis, F. (2013). Economic implications of reducing carbon emissions from energy use and industrial processes in Brazil. *Journal of Environmental Management*, *130*, 436–446.

Coetzee, K., & Winkler, H. (2014). The international policy context for mitigation actions. *Climate and Development*, *6* (suppl. 1), 4–11.

Combet, E. (2013). *Fiscalité carbone et progrès social – Application au cas français*. Paris: École des Hautes Etudes en Sciences Sociales.

Cornwell, A., & Creedy, J. (1996). Carbon taxation, prices and inequality in Australia. *Fiscal Studies*, *17*(3), 21–38.

Davies, R. (2012). *Observations on CGE modelling*. Cape Town: CDKN Workshop and MAPS Econ Lab.

Dissou, Y., & Siddiqui, M. S. (2014). Can carbon taxes be progressive? *Energy Economics*, *42*, 88–100.

Fisher-Vanden, K. A., Shukla, P. R., Edmonds, J. A., Kim, S. H., & Pitcher, H. M. (1997). Carbon taxes and India. *Energy Economics*, *19*, 289–325.

Fullerton, D., & Heutel, G. (2007). The general equilibrium incidence of environmental taxes. *Journal of Public Economics*, *91*, 571–591.

Gini, C. (1909/1997). Concentration and dependency ratios. English translation in *Rivista di Politica Economica*, *87*, 769–789.

González, F. (2012). Distributional effects of carbon taxes: The case of Mexico. *Energy Economics*, *34*, 2102–2115.

Greening, L. A., Greene, D. L., & Difiglio, C. (2000). Energy efficiency and consumption: The rebound effect: A survey. *Energy Policy*, *28*, 389–401.

Guilhoto, J. J. M., & Sesso filho, U. A. (2010). Estimação da Matriz Insumo-Produto Utilizando Dados Preliminares das Contas Nacionais: Aplicação e Análise de Indicadores Econômicos para o Brasil em 2005. *Economia & Tecnologia*, Ano 6, v. *23*, Outubro, UFPR/TECPAR.

Gurgel, A. C., & Paltsev, S. (2014). Cost of reducing GHG emissions in Brazil. *Climate Policy*, *14*(2), 209–223.

Hällding, K., Jürisoo, M., Carson, M., & Atteridge, A. (2013). Rising powers: The evolving role of BASIC countries. *Climate Policy*, *13*(5), 608–631.

Heil, M. T., & Selden, T. M. (2001). Carbon emissions and economic development: Future trajectories based on historical experience. *Environmental and Development Economics*, *6*, 63–83.

Henriques, M. F. Jr. (2010). *Potencial de Redução de Emissão de Gases de Efeito Estufa pelo Uso de Energia no Setor Industrial Brasileiro*. Doctoral dissertation presented to the Energy Planning Program, COPPE/UFRJ, to obtain the title of Doctor in Energy Planning Sciences.

Herendeen, R. A. (1978). Input-output techniques and energy cost of commodities. *Energy Policy*, *6*, 162–165.

Hourcade, J. C. (1996). Estimating the Costs of Mitigating Greenhouse Gases, In *IPCC, Climate Change 1995. Economic and Social Dimensions of Climate Change. Contribution of Working Group III to the second Assessment Report of the IPCC, WMO and UNEP.* New York, NY: Cambridge University Press, chapter 8.

IBGE. (2004). *Pesquisa de Orçamentos Familiares 2002–2003 – Primeiros resultados, Diretoria de Pesquisas, Coordenação de Índices de Preços.* Instituto Brasileiro de Geografia e Estatística.

IBGE. (2010a). *Pesquisa de Orçamentos Familiares 2008–2009 – Despesas, rendimentos e condições de vida, Diretoria de*

Pesquisas – Coordenação de Trabalho e Rendimento. Instituto Brasileiro de Geografia e Estatística.

IBGE. (2010b). *POF 2008/09 mostra desigualdades e transformações no orçamento das famílias brasileiras*, Notícias – Comunicação Social de 23 de junho de 2010. Instituto Brasileiro de Geografia e Estatística. Retrieved November 2012, from http://www.ibge.gov.br/home/presidencia/noticias/noticia_visualiza.php?id_noticia=1648&id_pagina=1

IBGE. (2011). *Sistema de Contas Nacionais Brasil 2005–2009.* Contas Nacionais n. 34, Rio de Janeiro, Diretoria de Pesquisas – Coordenação de Contas Nacionais, Instituto Brasileiro de Geografia e Estatística.

IPEAdata. (2014). *Commercial exchange rate for sale: Real (R$) / U.S. dollar (U.S.$) – average*. Retrieved February 2014, from http://www.ipeadata.gov.br/

Jensen, J., & Tarr, D. (2002, January). *Trade, foreign exchange, and energy policies in the Islamic Republic of Iran: reform agenda, economic implications, and impact on the poor.* World Bank. Retrieved from http://elibrary.worldbank.org/action/showCitFormats?doi=10.1596%2F1813-9450-2768.

Joas, F., & Flachsland, C. (2014). The (ir) relevance of transaction costs in climate policy instrument choice: An analysis of the EU and the US. *Climate Policy.* Advance online publication. doi:10.1080/14693062.2014.968762.

Klinge Jacobsen, H., Birr-Pedersen, K., & Wier, M. (2003). Distributional implications of environmental taxation in Denmark. *Fiscal Studies*, *24*(4), 477–499.

La Rovere, E., Dubeux, C., Pereira, A. O.Jr & Wills, W. (2013). Beyond 2020: From deforestation to the energy challenge in Brazil. *Climate Policy – Special issue: Low Carbon Drivers for a Sustainable World*, *13*(1), 70–86.

La Rovere, E., Pereira Jr, A. O., Dubeux, C., & Wills, W. (2014). Climate change mitigation actions in Brazil. *Climate and Development*, *6*(suppl. 1), 25–33.

Leontief, W., & Ford, D. (1970). Environmental repercussions and the economic structure: An input-output approach. *The Review of Economics and Statistics*, *52*, 262–271.

Lofgren, H., Harris, R. L., & Robinson, S. (2002). *A standard computable general equilibrium (CGE) model in GAMS.* Microcomputers in Policy Research 5. Washington, DC: International Food Policy Research Institute.

Magalhães, A. S. (2013). *Economia de baixo carbono no Brasil: alternativas de políticas e custos de redução de emissões de gases de efeito estufa*. Doctoral dissertation presented to the CEDEPLAR/FACE/UFMG, to obtain the title of Doctor in Economics.

Margulis, S., Dubeux, C., & Marcovitch, J., (Eds.). (2010). *Economia da Mudança do Clima no Brasil: Custos e Oportunidades, General Coordination: Jacques Marcovitch*. São Paulo: IBEP Gráfica, 2010.

Metcalf, G. (2009). Designing a carbon tax to reduce U.S. greenhouse gas emissions. *Review of Environmental Economics and Policy*, *3*(1), 63–83.

Metcalf, G., & Weisbach, D. (2009). The design of a carbon tax. *Harvard Environmental Law Review*, *33*, 499–556.

Miller, R. E., & Blair, P. D. (2009). *Input-output analysis: Foundations and extensions* (2nd ed.). Cambridge: Cambridge University Press.

Mundaca, L., Mansoz, M., Neij, L., & Timilsina, G. R. (2013). Transaction costs analysis of low-carbon technologies. *Climate Policy*, *13*(4), 490–513.

Mundaca, L., Markandya, A., & Nørgaard, J. (2013). Walking away from a low-carbon economy? Recent and historical trends using a regional decomposition analysis. *Energy Policy*, *61*, 1471–1480.

Ojha, V. P. (2011). Climate change mitigation strategies in South Asia. In R. Jha (Ed.), *Routledge handbook of South Asian economics* (pp. 309–322). London: Routledge.

Pandey, R. (2002). Energy policy modeling: Agenda for developing countries. *Energy Policy*, *30*, 97–106.

Parry, I., & Bento, A. (2002). Estimating the welfare effect of congestion taxes: The critical importance of the other distortions within the transportation system. *Journal of Urban Economics*, *51*, 339–365.

Rathmann, R. (2012). *Impactos da adoção de metas de redução de emissão de gases de efeito estufa sobre a competitividade de setores industriais energointensivos do Brasil*. Doctoral dissertation presented to the Energy Planning Program, COPPE/UFRJ, to obtain the title of Doctor in Energy Planning Sciences.

Rich, D. (2004). Climate change, carbon taxes and international trade: An analysis of the emerging conflict between the Kyoto protocol and the WTO. *Environmental Economics and Policy*, *131* – Globalization and the Natural Environment, Berkeley Institute of the Environment. 14p.

Seroa da Motta, R. (2006). *Economia Ambiental*. Rio de Janeiro: Fundação Getúlio Vargas.

Shah, A., & Larsen, B. (1992). *Carbon taxes, the greenhouse effect, and developing countries, policy research* (Working Paper No. 957). Washington, DC: The World Bank.

Speck, S. (1999). Energy and carbon taxes and their distributional implications. *Energy Policy*, *27*, 659–667.

Stone, R., & Brown, A. (1962). *A social accounting matrix for 1960*. London: Chapman and Hall.

Timilsina, G., & Shrestha, R. M. (2002). General equilibrium analysis of economic and environmental effects of carbon tax in a developing country: Case of Thailand. *Environmental Economics and Policy Studies*, *5*, 179–211.

Tourinho, O. A. F., Napoleão, L. C. S., & Alves, Y. B. (2006). *Uma Matriz de Contabilidade Social para o Brasil em 2003* (Text for discussion 1242). Rio de Janeiro: IPEA.

Tourinho, O. A. F., Seroa Da Motta, R., & Alves, Y. B. (2003). *Uma aplicação ambiental de um modelo de equilíbrio geral* (Text for discussion 976). Rio de Janeiro: IPEA.

Van Heerden, J., Gerlagh, R., Blignaut, J., & Horridge, M. (2006). Searching for triple dividends in South Africa: Fighting CO_2 pollution and poverty while promoting growth. *The Energy Journal*, *27*(2), 113–142.

West, S., & Williams, R. (2004). Estimates from a consumer demand system: Implications for the incidence of environmental taxes. *Journal of Environmental Economics and Management*, *47*, 535–558.

Wier, M., Birr-Pedersen, K., Jacobsen, H. K., & Klok, J. (2005). Are CO_2 taxes regressive? Evidence from the Danish experience. *Ecological Economics*, *52*, 239–251.

Wills, W. (2013). *Modelagem dos efeitos de longo prazo de políticas de mitigação de emissão de gases de efeito estufa na economia do Brasil*. Doctoral dissertation presented to the Energy Planning Program, COPPE/UFRJ, to obtain the title of Doctor in Energy Planning Sciences.

Winkler, H., & Marquard, A. (2011). Analysis of the economic implications of a carbon tax. *Journal of Energy in Southern Africa*, *22*(1), 55–68.

Xu, W., Hong, L., He, L., Wang, S., & Chen, X. (2011). Supply-driven dynamic inoperability input-output price model for interdependent infrastructure systems. *Journal of Infrastructure Systems*, *17*, 151–162.

Zaghini, E. (1971). Solow prices and the dual stability paradox in the Leontief dynamic system. *Econometrica*, *39*(3), 625–632.

Annex 1. SAM for Brazil (in million R$) – base year 2005

		Productive sectors								Productive factors		
		Agriculture and Livestock	Forests	Energy (Non-eletric)	Industry	Electricity	Transportation	Services	Waste	Labor	Capital	Land
Productive sectors	Agriculture and Livestock	16.413	459	4.488	101.681	46	149	3.705	11			
	Forests	583	17	151	3.556	1	5	122	0			
	Energy (Non-eletric)	5.443	200	72.811	29.846	6.756	22.232	19.050	1.675			
	Industry	36.809	1.144	12.157	394.702	3.862	12.585	143.606	958			
	Electricity	961	30	6.435	22.204	13.636	2.323	19.428	3.382			
	Transportation	3.531	145	9.436	41.990	1.647	13.494	28.397	408			
	Services	11.095	355	21.080	143.597	8.506	24.086	347.321	2.109			
	Waste	238	8	1.596	5.506	3.382	576	4.818	839			
Productive factors	Labor	43.933	1.369	12.368	162.200	10.921	38.822	588.564	2.708			
	Capital	57.133	2.362	39.662	158.527	40.529	51.821	595.857	10.050			
	Land											
Households	HH1									9.573	756	
	HH2									19.447	1.682	
	HH3									53.936	4.854	
	HH4									32.066	3.512	
	HH5									63.369	7.693	
	HH6									64.642	6.924	
	HH7									106.087	18.488	
	HH8									78.571	18.285	
	HH9									117.352	22.474	
	HH10									316.375	108.206	
	Enterprises										1.871.842	
Government	Import Taxes	230	10	139	3.679	61	154	919	15			
	Excise Taxes	2.835	65	2.595	23.758	3.923	2.950	29.975	973			
	Industrial Products Taxes	41	2	221	4.996	85	91	2.931	21			
	Other taxes on products	2.072	79	9.018	23.716	1.595	4.665	24.987	396			
	Taxes on production	1.095	36	1.030	10.400	806	1.460	12.949	200			
	Subsidies on production	- 725	- 40	- 3	- 312	- 26	- 626	- 812	- 6			
	Taxes on income and assets											
	Other transfers and taxes										105.002	16.748
	Rest of the World	6.282	266	22.841	85.258	2.686	6.111	35.342	666	262	70.435	
	Capital Accumulation/ Savings											
	Total	187.969	6.508	216.026	1.215.303	98.415	180.898	1.857.159	24.405	861.680	2.240.152	16.748

Source: The authors.

Households													Capital Accumulation/Savings		
HH1	HH2	HH3	HH4	HH5	HH6	HH7	HH8	HH9	HH10	Enterprises	Government	Rest of the World	Gross Fixed Capital Formation	Changes in inventories	Total
4.366	3.973	5.781	2.255	3.374	2.625	3.165	1.788	1.825	2.737	0	6	18.647	10.968	- 494	187.969
148	135	196	77	115	89	107	61	62	93	0	0	628	375	- 14	6.508
1.392	1.646	3.777	1.546	3.278	2.785	5.075	3.717	4.419	8.262	7	104	19.460	105	2.437	216.026
19.817	21.448	40.255	17.253	29.921	24.586	39.610	27.565	31.278	58.456	26	390	196.519	100.772	1.585	1.215.303
1.667	2.048	4.483	1.933	3.228	2.431	4.098	2.470	2.803	3.986	4	63	691	25	86	98.415
4.434	5.345	11.051	5.044	8.312	5.748	8.878	4.773	4.540	5.863	162	2.415	10.806	4.384	95	180.898
19.214	24.818	56.608	27.449	49.754	44.436	79.669	61.172	82.102	175.588	28.423	423.925	57.754	167.610	487	1.857.159
567	672	1.275	565	801	614	973	543	540	678	1	16	171	6	21	24.405
												794			861.680
928	1.125	3.017	1.658	3.139	2.763	5.320	3.254	4.722	21.487	1.013.827	214.655	8.317			2.240.152
1	2	4	2	5	5	12	9	17	57	16.634					16.748
13	20	46	22	42	41	84	65	96	296	3.261	20.396				34.711
20	30	69	33	64	62	127	99	145	446	2.921	36.289				61.432
39	59	137	65	126	124	252	196	287	885	5.733	62.738				129.433
17	26	60	29	56	54	111	86	126	390	1.945	26.580				65.058
32	48	112	53	103	101	206	160	234	722	4.817	43.851				121.500
36	54	125	60	115	113	231	179	263	810	3.330	38.365				115.247
53	80	186	89	171	168	342	266	389	1.201	8.145	62.846				198.510
24	37	86	41	79	78	158	123	180	556	7.422	50.972				156.613
36	55	128	61	118	116	236	183	269	829	8.016	77.672				227.546
68	103	238	113	219	215	438	340	498	1.537	52.888	185.102				666.340
344	791	2.920	1.627	3.685	3.766	6.799	5.043	7.157	16.832	6.711	614	8.775			1.936.907
73	87	160	79	140	136	192	142	188	488	-	-	-	1.976	29	8.897
2.920	3.443	6.381	3.127	5.582	5.414	7.635	5.644	7.486	19.409	0	-	8.793	10.264	370	153.541
384	452	838	411	733	711	1.003	741	983	2.549	-	-	2.912	3.894	115	24.115
1.478	1.742	3.229	1.583	2.825	2.740	3.864	2.856	3.788	9.822	414	606	8.462	8.209	287	118.433
										-	-	-	-	-	27.976
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	- 2.550
863	1.429	2.666	1.384	3.187	2.986	7.614	5.964	11.097	37.311	127.942	33				202.475
1.743	3.963	14.720	8.164	18.404	18.601	33.506	24.400	32.918	68.131	341.532	160.500	198			848.530
2.326	2.742	5.083	2.491	4.446	4.312	6.081	4.495	5.963	15.459	98	366	-	33.650	734	318.397
- 28.293	- 14.943	- 34.199	- 12.154	- 20.521	- 10.573	- 17.278	277	23.169	211.462	302.647	- 27.088	- 24.529			347.976
34.711	61.432	129.433	65.058	121.500	115.247	198.510	156.613	227.546	666.340	1.936.907	1.381.417	318.397	342.237	5.739	12.318.375

Source: The authors.