Green Growth Knowledge Platform (GGKP)
Fourth Annual Conference on
Transforming Development Through Inclusive Green Growth
6-7 September 2016
Jeju International Convention Center, Republic of Korea

THE TRANSITION TO A LOW CARBON ECONOMY AND ITS EFFECTS ON JOBS AND WELFARE - A LONG-TERM SCENARIO FOR BRAZIL

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ABSTRACT

This analysis derived from the one performed for the Deep Decarbonization Pathways Project (DDPP) (see La Rovere et al, 2015), which developed cross-cutting analyses for 16 major emitting countries to assess decarbonization strategies. In the Brazilian country study, a carbon tax is implemented from 2015 to 2050. In order to allow for a richer assessment of social aspects, this study comprises a better detailing of the household sector, concerning consumption levels, as well as of the impacts on labor market.

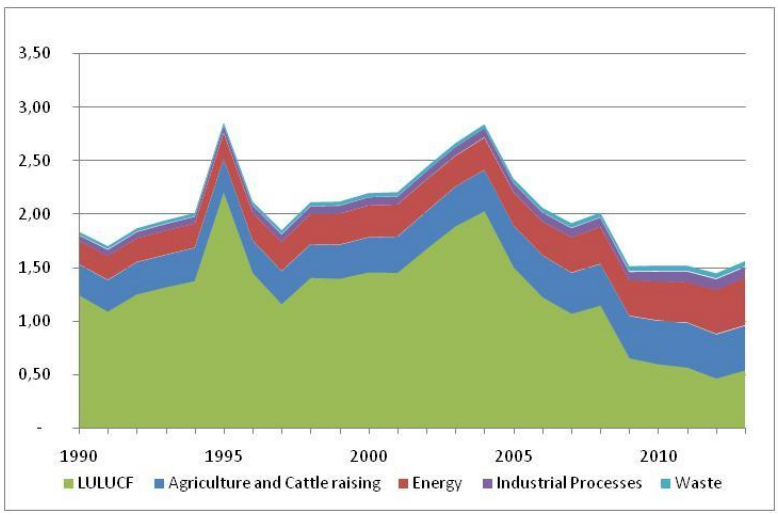
Our results show that it is possible to couple the transition to a low-carbon economy and other development goals, such as poverty alleviation and better income distribution. In our scenario, household welfare increases overall, but lower income consumption levels increase more than for the higher income strata. This can be partially explained by the impacts of a carbon tax on different productive sectors jobs (and the profile of labor skill they usually deploy, which is deeply related to workers' income levels). The fact that the carbon tax impacts sectoral prices differently, with greater impacts on energy-intensive sectors, also helps explaining our results: richer classes generally spend more in goods like fuels, for which prices increase considerably but do not account for a large share in the poorest's consumption basket. Lower classes spend a high share of their income on food products, for example, for which prices remain virtually unchanged.

Keyword: *carbon tax, Brazil, computable general equilibrium, inequality*

1. INTRODUCTION

Brazil is one the largest economies in the world, both in terms of GDP and foreign trade. Despite its medium average per capita GDP levels, social disparities, both regional or in terms of income, are deep and persistent.

Brazil's emissions profile is somewhat particular, compared to other similar developing economies. Unlike other BRICS countries, emissions related to the energy sector in Brazil are not as expressive, mainly due to its huge hydropower potential. Emissions come mostly from deforestation, related to agriculture and husbandry, which are high-emitting activities themselves.



Source: MCTI (2013)

Figure 1. Brazil emissions profile (Mt CO2e)

Nonetheless, due to substantial efforts to fight illegal deforestation, emissions from the LULUCF sector have been decreasing. On the other hand, energy emissions are expected to grow in the coming years, as the country resorts to fossil sources in order to complement power generation,

and also due to rising urbanization and the dominance of road transportation.

In the past decade, at the same time as emissions dropped, Brazil managed not only to increase GDP, but also to generate jobs, improve income distribution and shift millions of people out of poverty. In the context of sustainable development, decoupling GHG emissions and economic growth is imperative. Developing countries cannot prioritize environmental goals over their social agenda: instead, the two must be in tune.

The transition to a low carbon economy offers many opportunities to create green and decent jobs, especially in sectors related to renewable energy, sustainable agriculture, forestry and waste management. Meanwhile, sectors like oil and gas, mining and energy-intensive industry may experience significant losses. Since sectors differ in labor skill requirements and remuneration levels, shifting to this new profile will have major implications for workers among various sectors. To the extent that this affects workers´ income, changes in inequality and poverty levels are expected. In that sense, seeking a fair transition and the preservation of decent jobs is arguably necessary.

Moreover, putting a price on GHG emissions affects sectoral prices differently, according to their level of energy-intensity, and this also affects households' overall welfare. On one hand, poorer households generally spend a larger share of their income to meet their basic needs, that is, with food, energy for the dwelling, transportation and clothing, goods and services with high embedded energy. On the other hand, wealthier households have access to some goods and services with high energy requirements, such as private vehicles, air transportation and superfluous electrical appliances like dishwashers. Literature stands that a carbon tax is generally regressive, but because of varying consumption profiles, the aftermath of introducing a carbon tax is somewhat unclear, especially because it depends on the way it is implemented.

This work uses a hybrid Computable General Equilibrium model (IMACLIM-BR) to assess the impacts of mitigation options in various sectors, ranging from agriculture and land use to waste management, energy and industry sectors. We seek to assess the main socioeconomic impacts of transitioning to low-carbon, namely on GDP, jobs, income and consumption possibilities for different income classes.

This paper is organized as follows: section 2 describes the data and methodology, Section 3 presents and analyzes the main results. Section 4 concludes and discusses further research possibilities.

2. DATA AND METHODS

IMACLIM-BR (Wills, 2013; Wills and Lefèvre, 2012) is a hybrid CGE model, developed to assess the macroeconomic and social implications of climate policies in the medium and long term in a comparative statics fashion. It combines top-down and bottom-up approaches using a double accounting system in which both physical and economic flows are balanced.

The model comprises six energy sectors (Biomass, Oil, Coal, Natural Gas, Electricity and Petroleum Products), seven industrial sectors (Pulp and Paper, Steel, Non-ferrous Metals, Cement, Chemical Products, Mining and Other Industrial Sectors), apart from the Agriculture and Livestock, Transport and Services sectors, and represents the Brazilian economy for a 45-year period, from 2005 to 2050. For a detailed description of IMACLIM-BR, please refer to Wills (2013).

The household sector is divided in three income classes, according to their total income measured in base-year minimum wages. Household consumption and income levels were calibrated using the 2003 National Household Budget Survey (POF), undertaken by the Brazilian Institute of Geography and Statistics (IBGE). The first income class represents the 16% poorer households, the second the 60% intermediary ones, and the third class represents the 24% richest households.

The evolution of some variables is exogenous to the model, informed by official governmental institutions such as the National Bureau of Geography and Statistics (IBGE) and Energy Research Enterprise (EPE). The National Long Term Energy Plan, PNE 2050 (EPE, 2014) foresees a strong economic development path, with a quadrupling of average GDP per capita by 2050. The participation of the industrial sector in GDP share shall decrease, while the opposite happens to the Services sector. Population is expected to peak between 2030 and 2040 and then start decreasing. Factor productivity evolution is consistent with these assumptions.

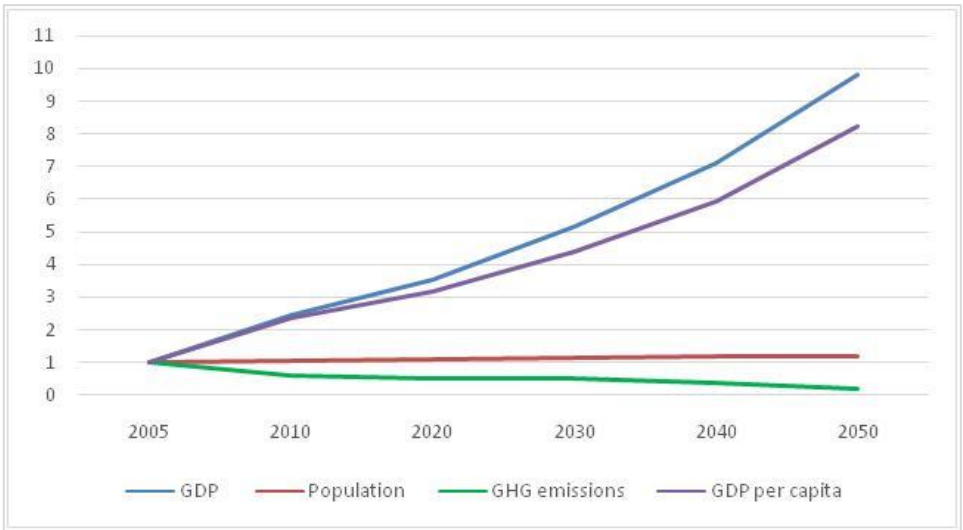
A carbon tax was simulated, growing linearly from 0 US$/tCO2e in 2015 to 100 US$ in 2030, and then to 150 US$ in 2050. This carbon tax would stimulate the introduction of a number of mitigation measures that were carefully chosen to compose the decarbonization scenario. They comprise various sectors, namely AFOLU, Residential, Services, Industry, Transport and Waste. The complete list of mitigation actions can be found in the DDPP report in La Rovere et al (2015). Carbon revenues are used to reduce payroll taxes, to stimulate the creation of new jobs and to offset the recessive effect of tax-induced price increases.

3. RESULTS AND DISCUSSION

Table 1. Main macroeconomic and social variables

	2005	**2050**
Population (million)	185	221
GDP (trillion 2005 US$ dollars)	0,88	8,64
GDP per capita (Thousand 2005 US$)	4,8	39,1
Jobs (million)	91,2	115,9
Unemployment rate	9,9%	5,5%
Gini coefficient	0,49	0,33
Total GHG Emissions (Mt CO2e)	2075	367
Emissions per capita (t CO2e)	11,2	1,7

Source: The authors



Source: The authors

Figure 2. GDP, Population and GHG Emissions compared to base year

The long-term scenario reaches a level of GHG emissions that is approximately 82% lower than in base-year, in which carbon intensity falls from 11,2 tons of CO2e per capita in 2005 to 1,7 in 2050.

Since many of the mitigation options present low and even negative abatement costs, our results show that their implementation do not jeopardize total output and jobs, even though there are winning and losing sectors, as depicted in Table 2.

Table 2. Jobs per sector

	2005	**2050**
Biomass	2 329	2 560
Coal	8	4
Oil	38	45
Natural Gas	5	5
Oil products	143	181
Electricity	233	363
Transport	3 858	9 735
Agriculture and cattle	19 000	11 843
Paper and Pulp	190	194
Cement	12	10
Steel	114	169
Non-ferrous metals	95	133
Chemicals	966	782
Mining	242	166
Rest of Industry	8 164	9 311
Services	55 816	80 388
Total	**91 212**	**115 889**

Source: The authors

The shift to renewable energy sources such as wind and solar promotes job creation in the power sector, which contributes to increasing total jobs in more than 50% in 2050. Employment decreases in the agriculture and cattle raising sector due to increased productivity and a smaller participation of these sectors in the economy. Jobs in oil, coal and carbon intensive sectors decrease whilst jobs in the biomass and services sectors increase. The former usually employs high-skilled labor, while workers in the latter are usually less skilled and hence poorer. Therefore, the results indicate a greater evolution in poor workers´ income, relative to high-skilled ones, leading to a better income distribution in the long run.

Moreover, the price variation of energy-intensive sectors is significantly higher than for the overall price index, especially regarding transport and oil-derived fuels (Table 3). These sectors account for a larger share of total expenses for the wealthier strata than for the poorer. Lower income households spend a higher share of their budget on food, for example, for which price variation was minor, leaving consumption possibilities virtually unchanged (see Table 4).

Table 3. Price variation per sector

	Annual price variation in the period
Biomass	0,6%
Coal	1,8%
Oil	2,2%
Natural Gas	0,5%
Oil products	1,8%
Electricity	2,0%
Transport	1,2%
Agriculture and cattle	0,0%
Paper and Pulp	0,6%
Cement	2,2%
Steel	1,4%
Non-ferrous metals	1,1%
Chemicals	0,1%
Mining	0,9%
Rest of Industry	0,4%
Services	0,5%

Source: The authors

Table 4. Per capita consumption per income class

	2005	**2050**	**Variation 2005-2050**
Class 1 (2005 US$)	912	3 376	270%
Class 2 (2005 US$)	2 254	5 861	160%
Class 3 (2005 US$)	8 452	18 143	115%

Source: The authors

4. CONCLUSION

This study sought to analyze how the transition to a low carbon economy may impact socioeconomic aspects in Brazil. This is an underlying quest, for the country must seek to reconcile environmental and social objectives, like all developing countries.

Our results show that in a high growth scenario, with high labor productivity gains, it is possible to deploy a transition to a low carbon future ensuring that other development goals, such as fighting social disparities, are safeguarded: in addition to a higher GDP and lower unemployment rates, in our scenario, poorer households have proportionally higher income and consumption levels in the long-run, when compared to wealthier ones. This is reflected in better income distribution indicators.

Future improvements of the IMACLIM-BR model should seek to have a more disaggregate representation of productive sectors, as well as of the household sector and labor qualification. Splitting households into per capita income deciles, for example, enables taking into account the varying household sizes across social classes in Brazil.

Acknowledgements
The authors would like to thank the Institute for Sustainable Development and International Relations (IDDRI) for coordinating the Deep Decarbonization Pathways Project (DDPP) and Claudio Gesteira, from the Brazilian modeling team. They are also grateful for the Mitigation Actions, Plans and Scenarios - MAPS project team, coordinated by SouthSouthNorth, as the synergies between the two studies are undeniable.

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