MAPS
Mitigation Action Plans & Scenarios

COPPE UFRJ Programa de Planejamento Energético

Centro Clima
CENTRO DE ESTUDOS INTEGRADOS SOBRE MEIO AMBIENTE E MUDANÇAS CLIMÁTICAS

Brazil

Brazilian Mitigation Scenarios Beyond 2020: Modelling and Methodologies

A Policy Brief

An output of the CDKN funded project on modelling the socio-economic implications of mitigation actions in developing countries

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EXECUTIVE SUMMARY

Brazil is a significant global economy, with projected positive economic growth but also with high carbon emissions.

Carbon constraints like a carbon tax or Cap & Trade scheme are ways to urge countries to reduce their carbon emissions.

This brief lays out key research and modelling work that will allow for robust analysis of the economic and social implications of implementing such carbon constraining measures on the Brazilian economy. This will inform policy making in this regard.

Through this work, researchers have:

- built modelling capacity within their team
- designed and selected the appropriate modelling tools to map Brazil's development pathways between 2005 and 2030
- tested the economic, emissions-related and social impacts of imposing a carbon constraint as a way of reducing the country's emissions

This brief shows the impacts of a carbon tax on heavy industries specifically, and the economic ramifications of different revenue 'recycling' options.

BRAZIL: BIG ECONOMY, AMBITIOUS EMISSIONS CUTS

Brazil is becoming one of the most important economies in the world, particularly in terms of global finance, trade, agriculture and food. But it is also one of the leading emitters of climate altering greenhouse gases, mostly because of its extensive deforestation. Large offshore oil discoveries mean it will become a significant fossil fuel supplier, impacting further on its emissions profile.

If Brazil wants to achieve sustainable development, it must address the challenges posed by climate change in the context of ongoing economic growth.

Brazil is committed to reducing emissions by between 36.1% and 38.9% by 2020, relative to a business-as-usual trajectory.

The country's emissions profile has already changed significantly. Voluntary emissions reduction efforts have brought the Land-use, Land-use change and Forest (LULUCF) sector's emissions down from 57% in 2005 to 22% in 2012. However the energy sector's emissions have doubled from 16% in 2005 to 32% in 2010, and these emissions will continue to rise.

Researchers from the Energy Planning Program (PPE/COPPE/UFRJ) and CentroClima (COPPE/UFRJ) are developing tools to help understand the economic and social implications of greenhouse gas reduction efforts.

The resulting 'scenarios' paint the picture of likely outcomes of emissions reduction measures between 2005 and 2030 as Brazil attempts to transform into a low carbon economy.

Choosing the right modelling tools

Researchers and modellers with the Brazilian chapter of the MAPS programme have built a tool that is custom-made for modelling the Brazilian economy, called the IMACLIM-Brazil model. This model:

- incorporates emissions from energy, land use, industrial processes and waste sectors
- simulates the economic and social ripple effects of emissions cuts
- reflects the implications of policy measures such as carbon taxes or carbon trading on productivity of sectors, contribution to GDP, emissions profiles and employment rates

This model is combined with other off-the-shelf modelling tools which are able to describe paths or 'scenarios', and their respective costs, of different emissions reduction options for the Brazilian economy in the short, medium and long term.

The backdrop: a changing global economy

The model assumes that the global economy will grow on the back of strong emerging economies, until 2020, bringing increased investment into Brazil. But from 2020, a slowdown in Chinese growth will lead a global economic downturn.

Building a reference case

In order to produce scenarios that show the implications of mitigation measures on the future economy, a reference scenario was first created that would show the country's macro-economic trajectory in the case of business continuing as usual between 2005 and 2030.

This reference scenario maps out the country's likely energy future, both in terms of energy demand and supply, and the associated carbon emissions. Because Brazil has high emissions from land use and deforestation, it was important to incorporate future land use and deforestation changes into the reference scenario, too.

When the state puts a price on carbon
The COPPE research team wanted to see how an emissions reduction measure, such as putting a price on carbon through a carbon tax or Cap & Trade system, impacts the wider economy. This is illustrated through showing how these scenarios differ from the reference scenario.

A carbon constraining policy, such as a carbon tax, 'shocks' the reference scenario, forcing sectors to trade off between factors of production on the energy supply side, or consumption levels on the energy demand side. The modelling tries to reflect innovation and technology changes, how the energy system responds to this iterative learning, and the resulting emissions profile of the country.

A distinction was made between four factors of production: energy, material, labour and capital. However the modelling only changes the energy and capital intensities of the industrial goods, while labour and material intensities remain constant, regardless of whether or not a carbon tax is applied. The modelling reflects the trades-off between overall energy consumption and capital, and trades-off between energy sources (fossil fuel versus biomass, coal and oil versus natural gas).

This stage of the modelling did not include land-use change emissions in a carbon tax scenario.

WHAT THE MODELS SAY

Heavy industry
The ramifications of a carbon tax on oil refining were considered, as well as six industrial sectors, namely paper, cement, steel, aluminium and non-ferrous metals, chemicals and mining.

Almost every sector shows the same behaviour as the carbon price increases:
(i) for small carbon prices, global energy efficiency gains are triggered and quickly plateau
(ii) for medium carbon prices, industry substitutes fossil fuel for renewable biomass.

'Recycling' the revenues
Once the Brazilian government has gathered the income from the tax or a Cap & Trade scheme, it can feed the money back into the economy. The macroeconomic impacts of three types of 'revenue recycling' options were considered, where the carbon tax ranged from 0 and 200 R$/$tCO_2$:

Option 0: carbon revenues are used to decrease public debt and are not recycled
Option 1: carbon revenues are used to decrease payroll taxes under the constraint of budget neutrality
Option 2: carbon revenues are divided between households

Impact on GDP
Channelling revenues into decreasing payroll taxes (*Option 1*) boosts GDP more than sending revenues to households (*Option 2*), which is always bigger than GDP in Option 0 (if compared with the same level of carbon tax).

But this has a smaller impact over the economy because it stimulates new job creation, and thus, increases households' income and consumption, reduces the recessive impact of the carbon tax.

When the tax is between 0 and 50 R$/$tCO_2$, there is a 'double dividend': a reduction in GHG emissions and stronger economy at the same time.

Impact on emissions reduction
Emissions reduce sharply with a carbon tax between 0 and 50 R$/$tCO_2$ because the tax triggers a recession. However by **not recycling the revenue** (*Option 0*), and instead paying off government debt, the recession is greater, and emissions therefore lower.

Impact on price index

Channelling revenues into decreasing payroll taxes (*Option 1*) reduces tax on labour, cutting costs for the productive sector and at the same time increasing households' consumption by creating more jobs.

However **dividing it between households** (*Option* 2) pushes up prices because of increased income of households. This option favours households' consumption but not investments on the productive sector.

Impact on unemployment

Not recycling the revenue, in other words using it to pay off public debt (*Option 0*) triggers a big economic recession. With a 200 R$/tCO$_2$ carbon tax the unemployment rate goes up to 18%, over double that of the reference scenario (around 7%).

Channelling revenues into decreasing payroll taxes *(Option 1)* is promising. Reducing tax on labour keeps the unemployment rate below 9% even with a 200 R$/tCO$_2$ tax. At 22 R$/tCO$_2$ carbon tax, unemployment drops to 5.8%, significantly lower than the 7% unemployment rate of the reference scenario.

Impact on total debt

Since **not recycling the revenue** (*Option 0*) uses all the carbon revenues to pay off government debt, the total debt in this case is the lowest one.

Channelling revenues into decreasing payroll taxes (*Option 1*), where the tax is between 0 and 100 R$/tCO$_2$, produces double dividends: it reduces emissions, pushes up the GDP and lowers unemployment. A carbon tax under a 22 R$/tCO$_2$ produces a GDP almost 2% higher than in the reference scenario, while achieving a GHG emissions reduction of almost 10% compared to the same scenario. Beyond that, and the tax pushes the economy towards recession.

Focus on power – carbon taxing tomorrow's energy sector

This modelling process calculates the new energy prices when a carbon tax is applied to thermal electricity generation, maps how the economy responds and subsequently how energy demand changes. Two different models are used in this process, reflecting different potential responses both in terms of decreased productivity across the sectors, how this could impact on their contribution to GDP and what the likely recession will be in the case of a carbon tax or Cape & Trade scheme.

The results show that the adjustment made in the electricity sector makes the environmental policies analysis more robust when certain modelling processes are used.

NEXT STEPS

COPPE researchers and modellers will continue to build capacity within the team as they carry on with the modelling, with the same models being used for the scenario-building process. This will allow for the further analysis of the impacts of carbon constraining policies on GDP, employment and income distribution.

To access the working paper on which this brief is based, please see www.erc.uct.ac.za or email amaro@ppe.ufrj.br