

**ON THE  
ENVIRONMENTAL, ECONOMIC,  
AND BUDGETARY EFFECTS  
OF A CARBON TAX  
IN PORTUGAL**

Alfredo Marvão Pereira and Rui Manuel Pereira

Department of Economics  
The College of William and Mary  
Williamsburg VA 23187

**SOBRE OS EFEITOS  
AMBIENTAIS E ECONÓMICOS  
DE UM NOVO  
IMPOSTO SOBRE O CARBONO  
Necessidade e Virtuosidade**

Alfredo Marvão Pereira and Rui Manuel Pereira

Department of Economics  
The College of William and Mary  
Williamsburg VA 23187

# 1. Introduction

## **2. The Dynamic General Equilibrium Model**

## 2. The Dynamic General Equilibrium Model

- We examine the economic and budgetary effects of environmental fiscal reform in the context of a **dynamic general equilibrium model**.
  - This model incorporates fully dynamic optimization behavior, endogenous growth, and a detailed modeling of public sector activities, both tax revenues and consumption and investment spending.
  - The key distinguishing feature of this model in the applied climate policy literature is its focus on endogenous growth and the associated treatment of public sector optimization behavior [see Conrad (1999) and Bergman (2005) for literature surveys].

## 2. The Dynamic General Equilibrium Model

The model has been used to study the impact of tax reform (Pereira and Rodrigues, 2001), social security reform (Pereira and Rodrigues, 2006) and, more recently, energy and environmental policies (Pereira and Pereira, 2011a, 2011b).

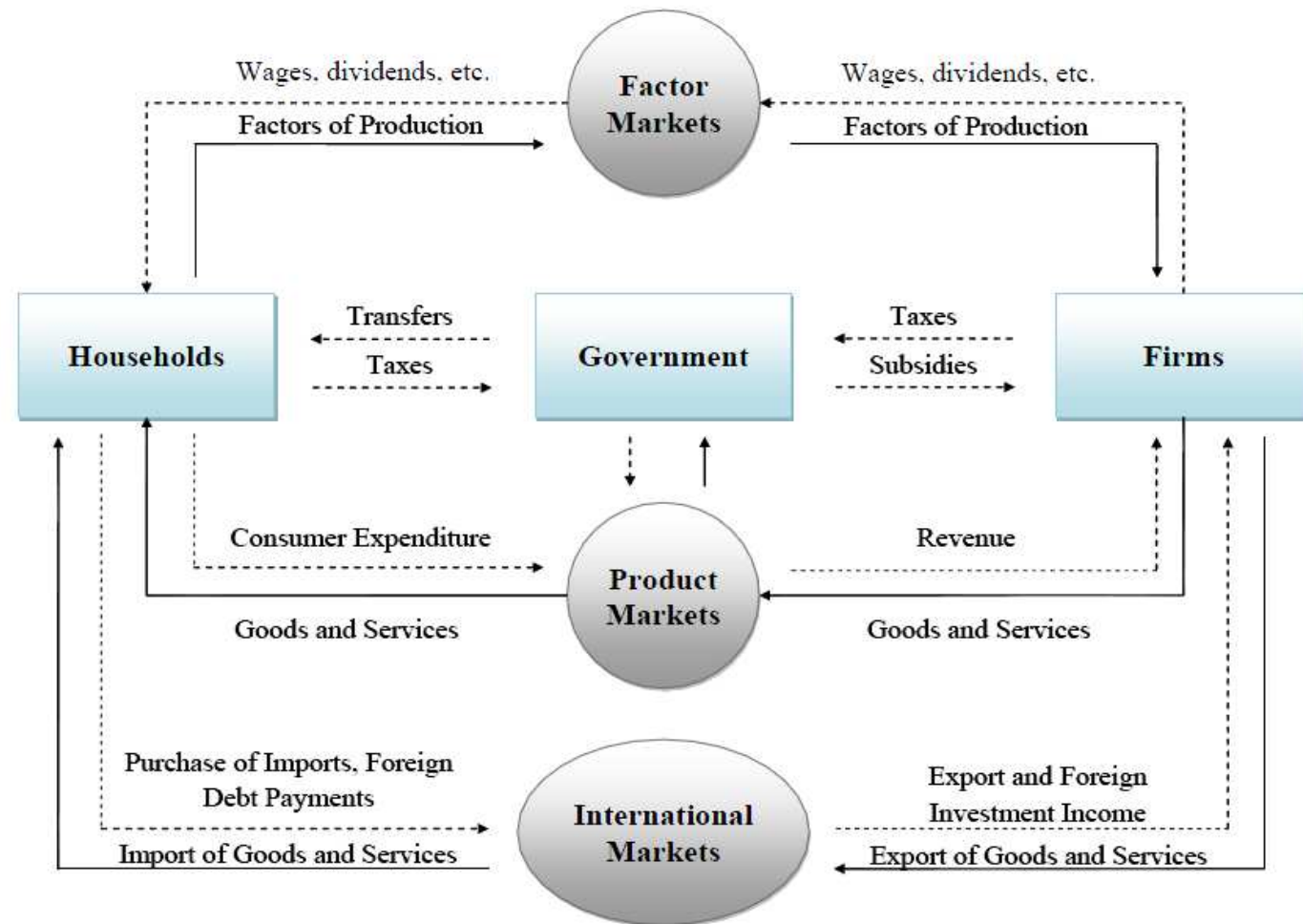
Bring together two important strands of the taxation literature.

- Considers the tax system in great detail.
  - in the tradition of Auerbach and Kotlikoff (1984,1987), Goulder and Thalmann (1993), Goulder and Summers (1989), Kotlikoff (1995, 1996), and Pereira (1994,1999a).
- Insights of the endogenous growth literature
  - in the tradition of Barro (1990), Barro and Sala-i-Martin (1992, 1995), Osang and Pereira (1996), Pecorino (1993), and Romer (1986) among many others.

## 2. The Dynamic General Equilibrium Model

- We consider a decentralized economy in a **dynamic general-equilibrium framework**.
  - All agents are price-takers and have perfect foresight.
  - There are four sectors in the economy – the production sector, the household sector, the public sector and the foreign sector.
  - The trajectory for the economy is described by the optimal evolution of eight stock and five shadow price variables.

## 2. The Dynamic General Equilibrium Model





## 2. The Dynamic General Equilibrium Model

- Data
  - Flow data take the average value between 1998-2013;
  - Stocks defined at 2013 levels.
- Calibration
  - Steady State calibration;
  - Values defined in the literature.

The model solution is that for a system of thirteen nonlinear first order difference equations, together with accounting identities, first-order conditions within each time period and equilibrium conditions.

- The model is implemented in General Algebraic Modeling System (GAMS) and solved with the Minos Solver.

### **3. A Carbon Tax in Portugal - is it necessary?**

**Table 1:  
Fossil Fuel Price Scenario**

	2013	2015	2020	2025	2030
<b>European Commission Forecast (EC)</b>					
<b>Crude Oil</b>	1.00	1.10	1.32	1.36	1.38
<b>Coal</b>	1.00	1.17	1.17	1.25	1.25
<b>Natural Gas</b>	1.00	1.12	1.52	1.43	1.61
<b>Crude Oil/Coal Price Ratio</b>	1.00	0.94	1.13	1.09	1.10
<b>Natural Gas/Coal Price Ratio</b>	1.00	0.96	1.30	1.14	1.29
<b>Crude Oil/Natural Gas Price Ratio</b>	1.00	0.98	0.87	0.95	0.86
<b>Reference Case (REF)</b>					
<b>Crude Oil</b>	1.00	1.02	1.06	1.09	1.11
<b>Coal</b>	1.00	1.07	1.13	1.20	1.20
<b>Natural Gas</b>	1.00	1.02	1.19	1.12	1.26
<b>Crude Oil/Coal Price Ratio</b>	1.00	0.95	0.94	0.91	0.93
<b>Natural Gas/Coal Price Ratio</b>	1.00	0.95	1.05	0.93	1.05
<b>Crude Oil/Natural Gas Price Ratio</b>	1.00	1.00	0.90	0.98	0.89
<b>Future Market Case (MKT)</b>					
<b>Crude Oil</b>	1.00	0.94	0.80	0.82	0.83
<b>Coal</b>	1.00	0.98	1.08	1.16	1.16
<b>Natural Gas</b>	1.00	0.92	0.86	0.81	0.91
<b>Crude Oil/Coal Price Ratio</b>	1.00	0.96	0.74	0.71	0.72
<b>Natural Gas/Coal Price Ratio</b>	1.00	0.94	0.82	0.70	0.78
<b>Crude Oil/Natural Gas Price Ratio</b>	1.00	1.02	0.90	1.01	0.92

**Table 2:  
On the Effects of Fossil Fuel Prices  
Central Scenario**

	2020	2025	2030	2050
<b>Energy</b>				
Total Energy Demand	-2.17	-3.11	-3.74	-6.96
Demand for Fossil Fuels	-3.43	-4.99	-6.16	-11.20
Crude Oil	-2.20	-3.47	-4.45	-8.75
Coal	-4.60	-9.92	-8.31	-15.34
Natural Gas	-7.30	-6.02	-10.99	-16.94
Investment in Wind Energy	13.46	14.61	16.60	21.51
Wind Energy Infrastructures	4.98	7.54	9.94	16.98
<b>Carbon Dioxide Emissions from Fossil Fuel Combustion</b>	<b>-3.33</b>	<b>-5.15</b>	<b>-6.07</b>	<b>-11.16</b>
<b>Change as a percent of 1990 levels</b>	<b>-3.99</b>	<b>-6.49</b>	<b>-8.03</b>	<b>-17.98</b>
<b>Economy</b>				
Growth Rate of GDP (Percent Change over Previous Period)	0.95	0.95	0.94	0.94
GDP	-0.02	-0.22	-0.45	-1.45
Private Consumption	-0.95	-0.95	-0.96	-0.98
Private Investment	-0.81	-1.14	-1.47	-2.74
Private Capital	-0.20	-0.42	-0.67	-1.81
Imported Energy	4.23	5.47	6.92	11.96
Foreign Debt	-3.64	-6.09	-8.45	-15.89
<b>Labor Markets</b>				
Employment	0.34	0.24	0.12	-0.38
Wages	-0.46	-0.58	-0.71	-1.28
<b>Public Sector</b>				
Public Debt	-2.29	-3.80	-5.24	-9.62
Public Expenditures	-2.10	-2.13	-2.16	-2.25
Public Consumption	-3.22	-3.18	-3.13	-2.92
Public Investment	-0.66	-0.97	-1.29	-2.54
Investment in Human Capital	-0.49	-0.55	-0.60	-0.80
Public Capital	-0.19	-0.42	-0.67	-1.84
Human Capital	-0.03	-0.06	-0.08	-0.20
Tax Revenues	-0.33	-0.47	-0.64	-1.30
Personal Income Tax (IRS)	-0.22	-0.61	-1.04	-2.63
Corporate Income Tax (IRC)	0.16	-0.04	-0.29	-1.42
Value Added Tax (IVA)	-1.02	-1.08	-1.13	-1.34
Social Security Contributions (TSU)	-0.15	-0.39	-0.68	-1.86

**Table 3:  
On the Effects of Fossil Fuel Prices  
Alternative Scenarios**

	2020	2025	2030	2050
<b>Fossil Fuel Price Scenario: MKT</b>				
Carbon Dioxide Emissions	5.29	4.55	3.63	-1.38
GDP	0.60	0.73	0.70	0.19
Labor Demand	0.27	0.32	0.29	0.02
Foreign Debt	0.36	-0.57	-1.78	-6.52
Public Debt	-0.08	-0.76	-1.56	-4.48
<b>Fossil Fuel Price Scenario: Central</b>				
Carbon Dioxide Emissions	-3.33	-5.15	-6.07	-11.16
GDP	-0.02	-0.22	-0.45	-1.45
Labor Demand	0.34	0.24	0.12	-0.38
Foreign Debt	-3.64	-6.09	-8.45	-15.89
Public Debt	-2.29	-3.80	-5.24	-9.62
<b>Fossil Fuel Price Scenario: EC</b>				
Carbon Dioxide Emissions	-9.36	-11.80	-12.75	-17.93
GDP	-0.58	-1.07	-1.48	-2.93
Labor Demand	0.41	0.17	-0.03	-0.75
Foreign Debt	-7.19	-11.01	-14.39	-24.25
Public Debt	-4.24	-6.50	-8.49	-14.18

**Table 4:**  
**On the Effects of Energy Efficiency Improvements**  
**Annual Gain of 2%**

	2020	2025	2030	2050
<b>Energy</b>				
Total Energy Demand	-7.65	-9.72	-10.37	-9.94
Demand for Fossil Fuels	-7.95	-9.86	-10.32	-9.49
Crude Oil	-7.98	-9.96	-10.47	-9.75
Coal	-8.00	-9.47	-10.16	-9.05
Natural Gas	-7.77	-9.88	-9.86	-8.88
Investment in Wind Energy	-16.26	-15.18	-14.16	-12.83
Wind Energy Infrastructures	-6.00	-8.92	-10.64	-12.45
<b>Carbon Dioxide Emissions from Fossil Fuel Combustion</b>	<b>-7.96</b>	<b>-9.85</b>	<b>-10.33</b>	<b>-9.50</b>
<b>Change relative to 1990 levels</b>	<b>-9.53</b>	<b>-12.40</b>	<b>-13.67</b>	<b>-15.31</b>
<b>Economy</b>				
Growth Rate of GDP (Percent Change over Previous Period)	1.03	1.00	0.98	0.96
GDP	0.37	0.69	0.91	1.35
Private Consumption	0.96	0.96	0.96	0.97
Private Investment	1.63	1.77	1.82	2.00
Private Capital	0.51	0.85	1.12	1.71
Imported Energy	-8.56	-10.93	-11.75	-11.97
Foreign Debt	3.29	4.82	5.90	8.23
<b>Labor Markets</b>				
Employment	-0.14	0.03	0.14	0.34
Wages	0.75	0.96	1.08	1.26
<b>Public Sector</b>				
Public Debt	1.84	2.69	3.29	4.55
Public Expenditures	1.94	1.92	1.92	1.93
Public Consumption	2.81	2.73	2.69	2.60
Public Investment	1.45	1.61	1.69	1.93
Investment in Human Capital	0.40	0.44	0.47	0.58
Public Capital	0.55	0.91	1.18	1.73
Human Capital	0.03	0.05	0.07	0.15
Tax Revenues	0.55	0.77	0.91	1.17
Personal Income Tax (IRS)	0.46	1.01	1.38	2.05
Corporate Income Tax (IRC)	0.17	0.68	1.02	1.61
Value Added Tax (IVA)	1.14	1.16	1.17	1.20
Social Security Contributions (TSU)	0.64	1.04	1.29	1.75

**Table 5:  
On the Effects of Energy Efficiency  
Alternative Scenarios**

	2020	2025	2030	2050
<b>Annual Energy Efficiency Improvements: 1.5</b>				
Carbon Dioxide Emissions	-6.14	-7.65	-8.04	-7.38
GDP	0.29	0.54	0.71	1.05
Labor Demand	-0.11	0.02	0.11	0.27
Foreign Debt	2.57	3.77	4.63	6.45
Public Debt	1.44	2.11	2.57	3.56
<b>Annual Energy Efficiency Improvements: 2.0</b>				
Carbon Dioxide Emissions	-7.96	-9.85	-10.33	-9.50
GDP	0.37	0.69	0.91	1.35
Labor Demand	-0.14	0.03	0.14	0.34
Foreign Debt	3.29	4.82	5.90	8.23
Public Debt	1.84	2.69	3.29	4.55
<b>Annual Energy Efficiency Improvements: 2.5</b>				
Carbon Dioxide Emissions	-9.68	-11.90	-12.46	-11.47
GDP	0.45	0.84	1.10	1.62
Labor Demand	-0.17	0.04	0.16	0.41
Foreign Debt	3.95	5.78	7.08	9.87
Public Debt	2.21	3.22	3.94	5.46

**Table 6:**  
**On the Effects of a Carbon Tax**  
**15 Euros per tCO<sub>2</sub>**

	2020	2025	2030	2050
<b>Energy</b>				
Total Energy Demand	-6.26	-5.50	-5.32	-4.60
Demand for Fossil Fuels	-8.78	-8.25	-8.19	-7.31
Crude Oil	-5.94	-5.74	-5.65	-5.23
Coal	-26.38	-23.47	-23.88	-20.46
Natural Gas	-1.75	-2.45	-1.98	-1.92
Investment in Wind Energy	16.55	13.50	12.03	10.11
Wind Energy Infrastructures	8.00	10.10	10.90	10.75
<b>Carbon Dioxide Emissions from Fossil Fuel Combustion</b>	<b>-9.76</b>	<b>-9.10</b>	<b>-9.07</b>	<b>-8.06</b>
Change relative to 1990 levels	<b>-11.70</b>	<b>-11.45</b>	<b>-11.99</b>	<b>-12.99</b>
<b>Economy</b>				
Growth Rate of GDP (Percent Change over Previous Period)	0.99	0.97	0.96	0.95
GDP	-0.70	-0.87	-0.98	-1.21
Private Consumption	-0.36	-0.36	-0.35	-0.32
Private Investment	-1.68	-1.62	-1.58	-1.58
Private Capital	-0.67	-0.95	-1.14	-1.46
Imported Energy	-7.17	-7.14	-7.16	-7.23
Foreign Debt	-1.87	-2.74	-3.36	-4.65
<b>Labor Markets</b>				
Employment	-0.27	-0.34	-0.40	-0.50
Wages	-0.71	-0.78	-0.82	-0.86
<b>Public Sector</b>				
Public Debt	-0.86	-1.25	-1.52	-2.03
Public Expenditures	-1.52	-1.50	-1.49	-1.48
Public Consumption	-2.11	-2.07	-2.04	-1.97
Public Investment	-1.52	-1.49	-1.49	-1.55
Investment in Human Capital	-0.34	-0.36	-0.38	-0.46
Public Capital	-0.75	-1.03	-1.20	-1.47
Human Capital	-0.02	-0.04	-0.06	-0.12
Tax Revenues	0.34	0.21	0.13	-0.02
Personal Income Tax (IRS)	-0.74	-1.01	-1.19	-1.52
Corporate Income Tax (IRC)	-0.67	-0.93	-1.11	-1.42
Value Added Tax (IVA)	-0.65	-0.63	-0.62	-0.60
Social Security Contributions (TSU)	-1.00	-1.16	-1.27	-1.49



**Table 7:  
On the Effects of a Carbon Tax  
Alternative Scenarios**

	2020	2025	2030	2050
<b>CO2 Tax of 5€ per tCO2</b>				
Carbon Dioxide Emissions	-3.91	-3.60	-3.59	-3.13
GDP	-0.24	-0.30	-0.34	-0.42
Labor Demand	-0.10	-0.12	-0.14	-0.18
Foreign Debt	-0.65	-0.95	-1.17	-1.61
Public Debt	-0.30	-0.43	-0.52	-0.69
<b>CO2 Tax of 15€ per tCO2</b>				
Carbon Dioxide Emissions	-9.76	-9.10	-9.07	-8.06
GDP	-0.70	-0.87	-0.98	-1.21
Labor Demand	-0.27	-0.34	-0.40	-0.50
Foreign Debt	-1.87	-2.74	-3.36	-4.65
Public Debt	-0.86	-1.25	-1.52	-2.03
<b>CO2 Tax of 35€ per tCO2</b>				
Carbon Dioxide Emissions	-17.69	-16.70	-16.62	-15.07
GDP	-1.51	-1.89	-2.15	-2.66
Labor Demand	-0.58	-0.73	-0.85	-1.10
Foreign Debt	-4.10	-6.01	-7.38	-10.25
Public Debt	-1.89	-2.76	-3.37	-4.52

**Table 8:**  
**Summary of the Relative Roles of Fossil Fuel Prices,  
 Energy Efficiency Improvements and Carbon Taxation**

	2020	2025	2030	2050
<b>Carbon Dioxide Emissions</b>				
<b>Total Effect</b>	<b>-25.23</b>	<b>-30.34</b>	<b>-33.70</b>	<b>-46.28</b>
Fossil Fuel Prices	-3.99	-6.49	<b>-8.03</b>	-17.98
Energy Efficiency	-9.53	-12.40	<b>-13.67</b>	-15.31
Carbon Tax	-11.70	-11.45	<b>-11.99</b>	-12.99
<b>GDP</b>				
<b>Total Effect</b>	<b>-0.35</b>	<b>-0.39</b>	<b>-0.53</b>	<b>-1.31</b>
Fossil Fuel Prices	-0.02	-0.22	<b>-0.45</b>	-1.45
Energy Efficiency	0.37	0.69	<b>0.91</b>	1.35
Carbon Tax	-0.70	-0.87	<b>-0.98</b>	-1.21
<b>Labor Demand</b>				
<b>Total Effect</b>	<b>-0.07</b>	<b>-0.07</b>	<b>-0.14</b>	<b>-0.55</b>
Fossil Fuel Prices	0.34	0.24	<b>0.12</b>	-0.38
Energy Efficiency	-0.14	0.03	<b>0.14</b>	0.34
Carbon Tax	-0.27	-0.34	<b>-0.40</b>	-0.50
<b>Public Debt</b>				
<b>Total Effect</b>	<b>-1.30</b>	<b>-2.37</b>	<b>-3.48</b>	<b>-7.10</b>
Fossil Fuel Prices	-2.29	-3.80	<b>-5.24</b>	-9.62
Energy Efficiency	1.84	2.69	<b>3.29</b>	4.55
Carbon Tax	-0.86	-1.25	<b>-1.52</b>	-2.03

## **4. A Carbon Tax in Portugal - is it good?**

**Table 9:  
Effects of an Indexed Carbon Tax  
Without Recycling**

	2020	2025	2030	2050
<b>Energy</b>				
Total Energy Demand	-3.26	-5.72	-7.80	-6.86
Demand for Fossil Fuels	-5.04	-8.78	-11.92	-11.32
Crude Oil	-3.10	-6.04	-8.55	-8.44
Coal	-16.67	-25.36	-33.21	-29.84
Natural Gas	-0.67	-2.47	-3.20	-3.52
Investment in Wind Energy	21.18	25.15	24.03	17.50
Wind Energy Infrastructures	6.80	11.61	15.56	18.35
<b>Carbon Dioxide Emissions from Fossil Fuel Combustion</b>	<b>-5.68</b>	<b>-9.70</b>	<b>-13.13</b>	<b>-12.37</b>
<b>Economy</b>				
Growth Rate of GDP (Percent Change over Previous Period)	0.94	0.91	0.92	0.94
<b>GDP</b>	<b>-0.17</b>	<b>-0.54</b>	<b>-0.92</b>	<b>-1.55</b>
Private Consumption	-0.67	-0.67	-0.68	-0.71
Private Investment	-1.49	-1.97	-2.14	-2.35
Private Capital	-0.42	-0.79	-1.16	-1.96
Imported Energy	-3.92	-7.55	-10.66	-11.46
Foreign Debt/GDP	-1.70	-2.78	-3.67	-5.90
<b>Labor Markets</b>				
<b>Employment</b>	<b>0.15</b>	<b>-0.08</b>	<b>-0.31</b>	<b>-0.57</b>
Wages	-0.47	-0.76	-1.03	-1.17
<b>Public Sector</b>				
<b>Public Debt/GDP</b>	<b>0.51</b>	<b>1.07</b>	<b>1.74</b>	<b>3.96</b>
Public Expenditures	-0.23	-0.57	-0.91	-1.48
Public Consumption	-0.23	-0.57	-0.91	-1.48
Public Investment	-0.23	-0.57	-0.91	-1.48
Investment in Human Capital	-0.23	-0.57	-0.91	-1.48
Public Capital	-0.05	-0.17	-0.37	-1.15
Human Capital	-0.01	-0.02	-0.06	-0.29
Tax Revenues	0.19	0.32	0.38	-0.08
Personal Income Tax (IRS)	0.15	-0.29	-0.82	-1.27
Corporate Income Tax (IRC)	0.20	-0.33	-1.01	-1.83
Value Added Tax (IVA)	-0.73	-0.83	-0.88	-0.99
Social Security Contributions (TSU)	-0.33	-0.86	-1.39	-2.01

## **5. A Carbon Tax in Portugal**

**- Can it be designed to be good?**

**Table 10:  
Effects of an Indexed Carbon Tax  
Recycling Mechanisms**

	Carbon Dioxide Emissions		Employment		GDP		Foreign Debt /GDP		Public Debt /GDP	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
<b>No Additional Energy Efficiency Gains</b>										
<b>Lump Sum</b>	<b>-13.13</b>	<b>-12.37</b>	<b>-0.31</b>	<b>-0.57</b>	<b>-0.92</b>	<b>-1.55</b>	<b>-3.67</b>	<b>-5.90</b>	<b>1.74</b>	<b>3.96</b>
Value Added	-12.97	-12.36	<b>0.08</b>	-0.25	-0.71	-1.53	-5.47	-8.47	1.18	<b>-0.47</b>
Personal Income Tax	-12.62	-11.56	<b>0.54</b>	<b>0.46</b>	-0.25	-0.44	-0.53	-1.38	0.55	2.10
Social Security Contributions	-12.77	-11.82	<b>0.29</b>	<b>0.12</b>	-0.45	-0.79	-1.90	-3.70	<b>-0.51</b>	<b>-3.01</b>
Investment Tax Credit	-12.60	-10.41	-0.37	<b>0.18</b>	-0.22	<b>1.13</b>	3.48	8.27	0.45	2.11
<b>Additional Energy Efficiency Gain of 0.25%</b>										
Value Added	-14.07	-13.38	<b>0.07</b>	-0.24	-0.64	-1.40	-4.99	-7.78	0.91	<b>-1.07</b>
Personal Income Tax	-13.73	-12.60	<b>0.52</b>	<b>0.46</b>	-0.18	-0.32	-0.14	-0.83	0.30	1.47
Social Security Contributions	-13.87	-12.85	<b>0.27</b>	<b>0.13</b>	-0.38	-0.67	-1.49	-3.11	<b>-0.75</b>	<b>-3.56</b>
Investment Tax Credit	-13.71	-11.48	-0.38	<b>0.19</b>	-0.15	<b>1.23</b>	3.81	8.65	0.19	1.50
<b>Additional Energy Efficiency Gain of 0.5%</b>										
Value Added	-15.13	-14.35	<b>0.06</b>	-0.23	-0.57	-1.27	-4.53	-7.12	0.65	-1.65
Personal Income Tax	-14.80	-13.60	<b>0.50</b>	<b>0.46</b>	-0.12	-0.21	0.23	-0.31	0.05	0.87
Social Security Contributions	-14.94	-13.84	<b>0.26</b>	<b>0.14</b>	-0.31	-0.55	-1.10	-2.55	<b>-0.99</b>	<b>-4.09</b>
Investment Tax Credit	-14.78	-12.51	-0.38	<b>0.19</b>	-0.08	<b>1.32</b>	4.13	9.02	<b>-0.05</b>	0.91
<b>Additional Energy Efficiency Gain of 1.0%</b>										
Value Added	-17.13	-16.19	<b>0.04</b>	-0.21	-0.43	-1.03	-3.68	-5.90	0.16	<b>-2.73</b>
Personal Income Tax	-16.82	-15.48	<b>0.47</b>	<b>0.46</b>	<b>0.00</b>	<b>0.00</b>	0.92	0.67	<b>-0.41</b>	<b>-0.26</b>
Social Security Contributions	-16.95	-15.71	<b>0.23</b>	<b>0.15</b>	-0.18	-0.33	-0.37	-1.50	<b>-1.43</b>	<b>-5.09</b>
Investment Tax Credit	-16.79	-14.46	-0.38	<b>0.20</b>	<b>0.04</b>	<b>1.49</b>	4.72	9.70	<b>-0.51</b>	<b>-0.21</b>

**Table 11:  
Effects of an Indexed Carbon Tax  
Mixed Recycling Mechanisms**

CFI Share	TSU Share	IRS Share	Carbon Dioxide Emissions		Employment		GDP		Foreign Debt /GDP		Public Debt /GDP	
			2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
<b>No Additional Energy Efficiency Gains</b>												
0.50	0.00	0.50	-12.61	-10.97	<b>0.08</b>	<b>0.32</b>	-0.23	<b>0.37</b>	1.56	3.62	0.48	2.07
0.50	0.50	0.00	-12.68	-11.10	-0.05	<b>0.16</b>	-0.33	<b>0.19</b>	0.88	2.48	<b>-0.05</b>	<b>-0.47</b>
0.50	0.25	0.25	-12.64	-11.04	<b>0.02</b>	<b>0.24</b>	-0.28	<b>0.28</b>	1.22	3.05	0.22	0.80
<b>Additional Energy Efficiency Gain of 0.25%</b>												
0.50	0.00	0.50	-13.72	-12.03	<b>0.07</b>	<b>0.33</b>	-0.16	<b>0.47</b>	1.92	4.09	0.23	1.45
0.50	0.50	0.00	-13.79	-12.15	-0.06	<b>0.16</b>	-0.26	<b>0.29</b>	1.25	2.96	<b>-0.30</b>	<b>-1.05</b>
0.50	0.25	0.25	-13.75	-12.09	<b>0.01</b>	<b>0.24</b>	-0.21	<b>0.38</b>	1.58	3.53	<b>-0.03</b>	0.20
<b>Additional Energy Efficiency Gain of 0.5%</b>												
0.50	0.00	0.50	-14.79	-13.04	<b>0.06</b>	<b>0.33</b>	-0.10	<b>0.57</b>	2.26	4.52	<b>-0.02</b>	0.85
0.50	0.50	0.00	-14.86	-13.17	-0.06	<b>0.17</b>	-0.20	<b>0.40</b>	1.60	3.42	<b>-0.53</b>	<b>-1.61</b>
0.50	0.25	0.25	-14.82	-13.10	<b>0.00</b>	<b>0.25</b>	-0.15	<b>0.49</b>	1.93	3.97	<b>-0.28</b>	<b>-0.38</b>
<b>Additional Energy Efficiency Gain of 1.0%</b>												
0.50	0.00	0.50	-16.80	-14.96	<b>0.04</b>	<b>0.33</b>	<b>0.02</b>	<b>0.76</b>	2.89	5.34	<b>-0.48</b>	<b>-0.27</b>
0.50	0.50	0.00	-16.87	-15.08	-0.08	<b>0.18</b>	-0.07	<b>0.59</b>	2.25	4.28	<b>-0.98</b>	<b>-2.67</b>
<b>0.50</b>	<b>0.25</b>	<b>0.25</b>	<b>-16.84</b>	<b>-15.02</b>	<b>-0.02</b>	<b>0.26</b>	<b>-0.02</b>	<b>0.68</b>	<b>2.57</b>	<b>4.81</b>	<b>-0.73</b>	<b>-1.47</b>

**Table 12:  
Effects of an Indexed Carbon Tax  
Partial Revenue Recycling**

	Carbon Dioxide Emissions		Employment		GDP		Foreign Debt /GDP		Public Debt /GDP	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
<b>50% CFI - 50% IRS</b>										
25%	-17.12	-15.87	-0.17	-0.27	-0.41	-0.56	-1.46	-3.00	<b>-2.70</b>	<b>-11.05</b>
50%	-17.01	-15.56	-0.10	-0.07	-0.27	-0.12	0.01	-0.16	<b>-1.96</b>	<b>-7.45</b>
75%	-16.91	-15.26	-0.03	<b>0.13</b>	-0.12	<b>0.32</b>	1.47	2.62	<b>-1.22</b>	<b>-3.85</b>
100%	-16.80	-14.96	<b>0.04</b>	<b>0.33</b>	<b>0.02</b>	<b>0.76</b>	2.89	5.34	<b>-0.48</b>	<b>-0.27</b>
<b>50% CFI - 50% TSU</b>										
25%	-17.13	-15.90	-0.20	-0.31	-0.44	-0.60	-1.62	-3.27	<b>-2.83</b>	<b>-11.65</b>
50%	-17.05	-15.62	-0.16	-0.15	-0.32	-0.20	-0.31	-0.71	<b>-2.22</b>	<b>-8.65</b>
75%	-16.96	-15.35	-0.12	<b>0.01</b>	-0.19	<b>0.20</b>	0.98	1.81	<b>-1.60</b>	<b>-5.66</b>
100%	-16.87	-15.08	-0.08	<b>0.18</b>	-0.07	<b>0.59</b>	2.25	4.28	<b>-0.98</b>	<b>-2.67</b>
<b>50% CFI - 25% TSU - 25% IRS</b>										
<b>25%</b>	<b>-17.13</b>	<b>-15.88</b>	<b>-0.19</b>	<b>-0.29</b>	<b>-0.42</b>	<b>-0.58</b>	<b>-1.54</b>	<b>-3.14</b>	<b>-2.77</b>	<b>-11.35</b>
<b>50%</b>	<b>-17.03</b>	<b>-15.59</b>	<b>-0.13</b>	<b>-0.11</b>	<b>-0.29</b>	<b>-0.16</b>	<b>-0.15</b>	<b>-0.43</b>	<b>-2.09</b>	<b>-8.05</b>
<b>75%</b>	<b>-16.93</b>	<b>-15.30</b>	<b>-0.08</b>	<b>0.07</b>	<b>-0.16</b>	<b>0.26</b>	<b>1.22</b>	<b>2.22</b>	<b>-1.41</b>	<b>-4.76</b>
<b>100%</b>	<b>-16.84</b>	<b>-15.02</b>	<b>-0.02</b>	<b>0.26</b>	<b>-0.02</b>	<b>0.68</b>	<b>2.57</b>	<b>4.81</b>	<b>-0.73</b>	<b>-1.47</b>



# 7. Final Remarks

# Law Proposed by the Reform Commission

**1. Indexed Tax**

**2. Recycling ITS – 50%, TSU – 25%; IRS – 25%**

**3. Recycling always from 2015**

**4. Recycling linked to energy efficiency targets**

**Table 11:**  
**Effects of an Indexed Carbon Tax - Mixed Recycling Mechanisms**  
**REVISITED**

CFI Share	TSU Share	IRS Share	Carbon Dioxide Emissions		Employment		GDP		Foreign Debt /GDP		Public Debt /GDP	
			2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
<b>No Additional Energy Efficiency Gains</b>												
0.50	0.00	0.50	-12.61	-10.97	<b>0.08</b>	<b>0.32</b>	-0.23	<b>0.37</b>	1.56	3.62	0.48	2.07
0.50	0.50	0.00	-12.68	-11.10	-0.05	<b>0.16</b>	-0.33	<b>0.19</b>	0.88	2.48	<b>-0.05</b>	<b>-0.47</b>
0.50	0.25	0.25	-12.64	-11.04	<b>0.02</b>	<b>0.24</b>	-0.28	<b>0.28</b>	1.22	3.05	0.22	0.80
<b>Additional Energy Efficiency Gain of 0.25%</b>												
0.50	0.00	0.50	-13.72	-12.03	<b>0.07</b>	<b>0.33</b>	-0.16	<b>0.47</b>	1.92	4.09	0.23	1.45
0.50	0.50	0.00	-13.79	-12.15	-0.06	<b>0.16</b>	-0.26	<b>0.29</b>	1.25	2.96	<b>-0.30</b>	<b>-1.05</b>
0.50	0.25	0.25	-13.75	-12.09	<b>0.01</b>	<b>0.24</b>	-0.21	<b>0.38</b>	1.58	3.53	<b>-0.03</b>	0.20
<b>Additional Energy Efficiency Gain of 0.5%</b>												
0.50	0.00	0.50	-14.79	-13.04	<b>0.06</b>	<b>0.33</b>	-0.10	<b>0.57</b>	2.26	4.52	<b>-0.02</b>	0.85
0.50	0.50	0.00	-14.86	-13.17	-0.06	<b>0.17</b>	-0.20	<b>0.40</b>	1.60	3.42	<b>-0.53</b>	<b>-1.61</b>
0.50	0.25	0.25	-14.82	-13.10	<b>0.00</b>	<b>0.25</b>	-0.15	<b>0.49</b>	1.93	3.97	<b>-0.28</b>	<b>-0.38</b>
<b>Additional Energy Efficiency Gain of 1.0%</b>												
0.50	0.00	0.50	-16.80	-14.96	<b>0.04</b>	<b>0.33</b>	<b>0.02</b>	<b>0.76</b>	2.89	5.34	<b>-0.48</b>	<b>-0.27</b>
0.50	0.50	0.00	-16.87	-15.08	-0.08	<b>0.18</b>	-0.07	<b>0.59</b>	2.25	4.28	<b>-0.98</b>	<b>-2.67</b>
<b>0.50</b>	<b>0.25</b>	<b>0.25</b>	<b>-16.84</b>	<b>-15.02</b>	<b>-0.02</b>	<b>0.26</b>	<b>-0.02</b>	<b>0.68</b>	<b>2.57</b>	<b>4.81</b>	<b>-0.73</b>	<b>-1.47</b>

# Law Proposed by the Government and Approved By the Parliament

## Proposta de Lei no. 257/XII

### Motivation

This reform is rooted on a triple dividend, based on promoting sustainable economic growth and balanced public finances while at the same time enacting measures that protect the environment.

The environmental fiscal reform, through the increase in environmental taxes, allows the reductions in the tax burden in other margins ... and the increase of fiscal support for energy efficiency projects.”

# Law Proposed by the Government and Approved By the Parliament

**1. Indexed Tax**

**2. Recycling IRS – 100%**

**3. Only in 2015 – no recycling after**

**4. No energy efficiency targets**

**Table 10:  
Effects of an Indexed Carbon Tax - Recycling Mechanisms  
REVISITED**

	Carbon Dioxide Emissions		Employment		GDP		Foreign Debt /GDP		Public Debt /GDP	
	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
<b>No Additional Energy Efficiency Gains</b>										
Lump Sum	-13.13	-12.37	-0.31	-0.57	-0.92	-1.55	-3.67	-5.90	1.74	3.96
Value Added	-12.97	-12.36	<b>0.08</b>	-0.25	-0.71	-1.53	-5.47	-8.47	1.18	<b>-0.47</b>
<b>Personal Income Tax</b>	<b>-12.62</b>	<b>-11.56</b>	<b>0.54</b>	<b>0.46</b>	<b>-0.25</b>	<b>-0.44</b>	<b>-0.53</b>	<b>-1.38</b>	<b>0.55</b>	<b>2.10</b>
Social Security Contributions	-12.77	-11.82	<b>0.29</b>	<b>0.12</b>	-0.45	-0.79	-1.90	-3.70	<b>-0.51</b>	<b>-3.01</b>
Investment Tax Credit	-12.60	-10.41	-0.37	<b>0.18</b>	-0.22	<b>1.13</b>	3.48	8.27	0.45	2.11
<b>Additional Energy Efficiency Gain of 0.25%</b>										
Value Added	-14.07	-13.38	<b>0.07</b>	-0.24	-0.64	-1.40	-4.99	-7.78	0.91	<b>-1.07</b>
Personal Income Tax	-13.73	-12.60	<b>0.52</b>	<b>0.46</b>	-0.18	-0.32	-0.14	-0.83	0.30	1.47
Social Security Contributions	-13.87	-12.85	<b>0.27</b>	<b>0.13</b>	-0.38	-0.67	-1.49	-3.11	<b>-0.75</b>	<b>-3.56</b>
Investment Tax Credit	-13.71	-11.48	-0.38	<b>0.19</b>	-0.15	<b>1.23</b>	3.81	8.65	0.19	1.50
<b>Additional Energy Efficiency Gain of 0.5%</b>										
Value Added	-15.13	-14.35	<b>0.06</b>	-0.23	-0.57	-1.27	-4.53	-7.12	0.65	-1.65
Personal Income Tax	-14.80	-13.60	<b>0.50</b>	<b>0.46</b>	-0.12	-0.21	0.23	-0.31	0.05	0.87
Social Security Contributions	-14.94	-13.84	<b>0.26</b>	<b>0.14</b>	-0.31	-0.55	-1.10	-2.55	<b>-0.99</b>	<b>-4.09</b>
Investment Tax Credit	-14.78	-12.51	-0.38	<b>0.19</b>	-0.08	<b>1.32</b>	4.13	9.02	<b>-0.05</b>	0.91
<b>Additional Energy Efficiency Gain of 1.0%</b>										
Value Added	-17.13	-16.19	<b>0.04</b>	-0.21	-0.43	-1.03	-3.68	-5.90	0.16	<b>-2.73</b>
<b>Personal Income Tax</b>	<b>-16.82</b>	<b>-15.48</b>	<b>0.47</b>	<b>0.46</b>	<b>0.00</b>	<b>0.00</b>	<b>0.92</b>	<b>0.67</b>	<b>-0.41</b>	<b>-0.26</b>
Social Security Contributions	-16.95	-15.71	<b>0.23</b>	<b>0.15</b>	-0.18	-0.33	-0.37	-1.50	<b>-1.43</b>	<b>-5.09</b>
Investment Tax Credit	-16.79	-14.46	-0.38	<b>0.20</b>	<b>0.04</b>	<b>1.49</b>	4.72	9.70	<b>-0.51</b>	<b>-0.21</b>

**Table 9:  
Effects of an Indexed Carbon Tax - Without Recycling  
REVISITED**

	2020	2025	2030	2050
<b>Energy</b>				
Total Energy Demand	-3.26	-5.72	-7.80	-6.86
Demand for Fossil Fuels	-5.04	-8.78	-11.92	-11.32
Crude Oil	-3.10	-6.04	-8.55	-8.44
Coal	-16.67	-25.36	-33.21	-29.84
Natural Gas	-0.67	-2.47	-3.20	-3.52
Investment in Wind Energy	21.18	25.15	24.03	17.50
Wind Energy Infrastructures	6.80	11.61	15.56	18.35
<b>Carbon Dioxide Emissions from Fossil Fuel Combustion</b>	<b>-5.68</b>	<b>-9.70</b>	<b>-13.13</b>	<b>-12.37</b>
<b>Economy</b>				
Growth Rate of GDP (Percent Change over Previous Period)	0.94	0.91	0.92	0.94
<b>GDP</b>	<b>-0.17</b>	<b>-0.54</b>	<b>-0.92</b>	<b>-1.55</b>
Private Consumption	-0.67	-0.67	-0.68	-0.71
Private Investment	-1.49	-1.97	-2.14	-2.35
Private Capital	-0.42	-0.79	-1.16	-1.96
Imported Energy	-3.92	-7.55	-10.66	-11.46
Foreign Debt/GDP	-1.70	-2.78	-3.67	-5.90
<b>Labor Markets</b>				
<b>Employment</b>	<b>0.15</b>	<b>-0.08</b>	<b>-0.31</b>	<b>-0.57</b>
Wages	-0.47	-0.76	-1.03	-1.17
<b>Public Sector</b>				
<b>Public Debt/GDP</b>	<b>0.51</b>	<b>1.07</b>	<b>1.74</b>	<b>3.96</b>
Public Expenditures	-0.23	-0.57	-0.91	-1.48
Public Consumption	-0.23	-0.57	-0.91	-1.48
Public Investment	-0.23	-0.57	-0.91	-1.48
Investment in Human Capital	-0.23	-0.57	-0.91	-1.48
Public Capital	-0.05	-0.17	-0.37	-1.15
Human Capital	-0.01	-0.02	-0.06	-0.29
Tax Revenues	0.19	0.32	0.38	-0.08
Personal Income Tax (IRS)	0.15	-0.29	-0.82	-1.27
Corporate Income Tax (IRC)	0.20	-0.33	-1.01	-1.83
Value Added Tax (IVA)	-0.73	-0.83	-0.88	-0.99
Social Security Contributions (TSU)	-0.33	-0.86	-1.39	-2.01

**The End ...  
... or just ...  
The Beginning?**