Hacia el Futuro: Environment, Energy and the Economy in 21st Century Mexico

Ma. Eugenia Ibarrarán, Universidad de las Américas

Roy Boyd, Ohio University

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Up-coming book

Ibarrarán, María Eugenia and Roy G. Boyd (forthcoming). Hacia el Futuro: Energy, Economics and the Environment in 21st Century Mexico, Kluwer Academic Publishers.

Content

Part I

1. Introduction
2. Greenhouse Gas Emissions and Climate Change
3. Forecasting the Impact of Climate Change
4. Energy Use in Mexico
5. Economic Theory, Emissions Control, and Kyoto

Content (cont).

Part II

6. A Dynamic General Equilibrium Model
7. Simulation Results Under Competitive Scenarios
8. Simulation Results Under Imperfect Market Scenarios
9. Simulation Results with Emissions Trading
10. Conclusions

Special Features

- Combines science, economics, and policy-making
  - Science of climate change and evidence
  - Emissions worldwide, in Latin America and in Mexico
  - Regional and local impacts, especially for Mexico
  - Energy use and trends in Mexico, Brazil, Argentina and Venezuela
  - Economic analysis of climate change and possible solutions through incentives
  - International agreements

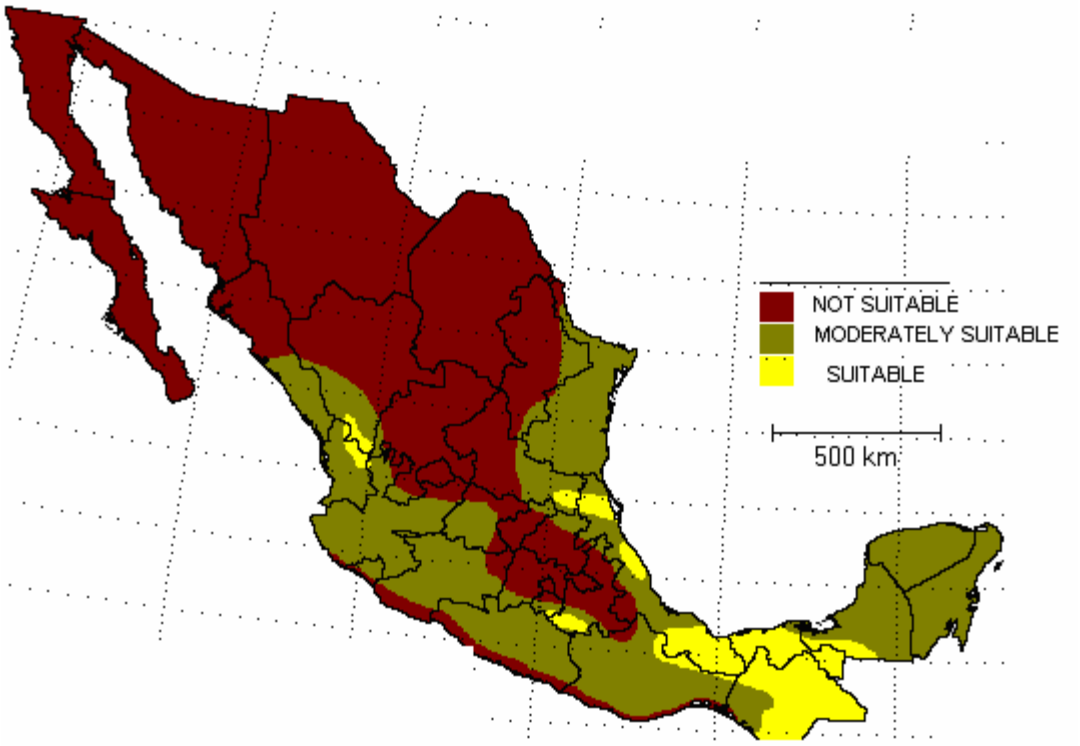
TABLE 1: National Priorities for V&A Assessment, by Sector

	COSTA RICA	EL SAL-VADOR	GUATE-MALA	HON-DURAS	MEXICO	NICA-RAGUA	PANAMA	CUBA
Agriculture	H	H	H	H	H	H	H	H
Water resources	H	—	H	H	H	M	H	H
Coastal zones	H	H	—	H	M	H	H	H
Human health	H	—	H	H	H	H	H	H
Forests	M	H	H	—	H	H	L	H
Biodiversity	H	—	—	—	H	M	—	H
Human settlements	H	H	—	—	—	—	—	H
Fisheries	—	H	—	—	—	M	—	—
Energy	M	—	—	—	—	H	—	—

Note: H = high; M = medium; L= low

Source: As reported by countries for this workshop in NCSP questionnaire.

Corn Production Scenario



Source: Semarnap, 1997

Desertification and Drought

Source: Semarnat, 1997

The Model

- In-depth description on CGE modeling
- Production, consumption, government, trade
- Capital accumulation
- Dynamic: runs for 20 time periods
- GAMS

THE MODEL

Production

$$V_t = \phi_t \left[\delta_L L_t^{(\sigma-1)/\sigma} + \delta_K K_t^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)} \quad (1)$$

Where $\delta_L, \delta_K > 0$ *and* $\delta_L + \delta_K = 1$

Consumption

$$Max\ U_c = \Sigma_t U_{c,t} (X_{c,t}, R_{c,t}) * (1+\rho)^{-t} \quad (2)$$

$t=1,\ldots,n$

$$s.t.\ \Sigma_t(TG_{c,t}+TF_{c,t}+(P_{L,t}*L_{c,t})+(r*K_t*S_{c,t}))=$$

$$\Sigma_t((INV_t*S_{c,t})+(P_{I,t}*X_{c,t})+(P_{L,t}*R_{c,t})) \quad (3)$$

Trade Balance $P_{m,t} * IM_{j,t} = P_{j,t} * EX_{j,t} + \Sigma TF_{c,t}$
$t=1,\ldots,n$

Labor Market $L_{t-1} = L_t (1+\gamma)$

γ includes population growth and labor-augmenting technological change

Capital Formation $K_{t+1} = K_t (1-d) + INV_t$
t=1,…,T

Government: As other agent, similar consumption structure, and also lum-sum transfers to agents, all subject to a budget constraint

Terminal conditions are imposed:

According to Lau, Puhlke, and Rutherford (1997)

(In a way such that resources are not wasted in the last period)

Closure rule (important in CGE models):

What sector adjusts automatically to close the model (think of Walras´Law)

In this model: Foreign sector

Producing Sectors, Production and Consumer Goods and Services

Table 6.1 Classification of Producing Sectors, Production and Consumer Goods and Services		
Producing Sectors	Production Goods	Consumer Goods and Services
1. Manufacturing	Manufacturing Goods	1. Food
2. Coal Mining	Coal	2. Energy
3. Chemicals and Plastics	Chemicals and Plastics	3. Autos
4. Agriculture	Agricultural goods	4. Gasoline
5. Services	Producer Services	5. Consumer Transport
6. Transportation	Transportation for production	6. Consumer Services
7. Electricity	Electricity	7. Housing and Household goods
8. Oil and Gas	Crude Petroleum	
9. Refining output	Natural Gas	
	Coke	
	Diesel	
	Fuel oil	
	LPG	
	Gasoline	
	Kerosene	
	Petrochemicals	

Market Structure

- Perfect Competition

- Imperfect Markets
  - Imperfect energy markets (PEMEX and CFE)
  - Unemployment

  Note: Depletion is explicitly incorportaed into the model.

Policies

- Comparing effects of mitigation policies
  - Elimination of subsidies to power
  - Technological change
  - Carbon taxes to fossil fuels
  - Tradable emission permits
    - Domestic trade
      - Forestry
      - Extractive Sectors (coal mining, oil and natural gas)
      - Emitting Sectors (electricity, refining, manuf, chem&plas)
    - International trade (with U.S.)
      - Mexico: Forestry
      - U.S.: Emitting and extractive sectors

Comparing costs of policies

- In terms of
  - Overall and sectoral growth
  - Production, consumption, trade
  - Changes in relative prices
  - Capital accumulation
  - Revenues
  - Welfare by income groups
  - CO_2 emissions

Main conclusions: Perfect Competition

- Importance of depletion and investment
- Carbon tax is costly: efficiency and equity
- Importance of technology,
  - Progressive on income distribution
  - Potential environmental costs

Summary Table: Summary CGE Results Data for Mexico for 2020 (Percentage Changes from Respective Scenarios)						
	Scenario1	Scenario2	Scenario3	Scenario4	Scenario5	Scenario6
GDP, trillions pesos	-1.813%	-0.208%	1.135%	0.921%	-0.770%	18.511%
Final level of Investment	-11.18%	-0.763%	3.751%	2.988%	-4.321%	13.889%
Oil output, trillions pesos	-37.090%	-0.206%	31.640%	31.434%	-14.621%	5.872%
Pow er output	-2.723%	-0.483%	15.637%	15.058%	-3.775%	16.391%
Consumption	9.541%	-0.288%	3.937%	3.525%	0.099%	15.459%
Imports	-0.006%	0.000%	0.011%	0.011%	-0.006%	-0.062%
Exports	-3.653%	-0.128%	2.337%	2.208%	-1.381%	6.499%
Exports oil	-37.131%	-0.152%	31.918%	31.766%	-14.557%	1.549%
BoP surplus	-3.647%	-0.128%	2.326%	2.197%	-1.376%	6.560%
Cumulated w elfare agent 1	-0.339%	-0.098%	0.431%	0.327%	-0.071%	12.463%
Cumulated w elfare agent 2	-0.297%	-0.093%	0.433%	0.338%	-0.075%	12.590%
Cumulated w elfare agent 3	-0.757%	-0.059%	0.209%	0.150%	0.019%	8.690%
Cumulated w elfare agent 4	-1.031%	0.084%	-0.042%	0.042%	0.138%	4.563%
Terminal capital stock	-2.372%	-0.361%	1.066%	0.708%	-1.680%	-0.716%
Cumulated Govt. revenue from PEMEX	-10.204%	0.325%	-4.545%	-4.221%	-4.407%	-3.191%
Cumulated Govt. revenue from CFE	2.326%	0.000%	-2.273%	-2.273%	0.000%	20.930%
Cum. Govt revenue from other sources	1.288%	-0.022%	1.404%	1.382%	2.552%	44.843%
CO2 Emissions, percent change	-33.877%	-0.245%	29.604%	29.429%	-14.422%	7.994%
Scenario1 is compared to Scenario0.						
Scenario2 is compared to Scenario1.						
Scenario3 is compared to Scenario1.						
Scenario4 is compared to Scenario1.						
Scenario5 is compared to Scenario4.						
Scenario6 is compared to Scenario5.						

Main conclusions: Monopoly and Unemployment

- Market power affects economy
- Technological change is crucial
  - Sticky wages and CO_2 tx disastrous if no TC
- CO_2 tax have to be conservative
- Unemployment: expansion-contraction
- Market power: welfare loss and slowdown
- Market power ambigous on environment

Summary Table 2: CGE Results Data for Mexico for 2020 (Percentage Changes from Respective Scenarios)						
	Scenario7	Scenario8	Scenario9	Scenario10	Scenario11	Scenario12
GDP, trillions pesos	2.349%	-24.958%	17.259%	-1.399%	-1.182%	-1.209%
Final level of Investment	10.062%	-98.093%	6.282%	-3.951%	-3.985%	-2.955%
Oil output, trillions pesos	12.585%	-34.833%	-13.868%	-14.883%	-24.356%	-14.755%
Pow er output	-1.930%	-33.105%	11.805%	-17.617%	-13.646%	-17.674%
Consumption	0.794%	-8.763%	104.229%	-0.561%	-3.840%	-0.646%
Imports	-0.005%	-0.006%	-0.062%	-0.011%	-0.011%	-0.017%
Exports	1.570%	-3.868%	3.750%	-1.721%	-2.018%	-1.594%
Exports oil	12.140%	-29.913%	-17.137%	-14.845%	-24.527%	-14.861%
BoP surplus	1.575%	-3.863%	3.812%	-1.710%	-2.006%	-1.577%
Cumulated w elfare agent 1	0.974%	-3.205%	14.424%	-0.380%	-0.436%	-0.306%
Cumulated w elfare agent 2	0.998%	-3.248%	14.571%	-0.375%	-0.436%	-0.304%
Cumulated w elfare agent 3	0.685%	-1.085%	10.112%	-0.237%	-0.208%	-0.232%
Cumulated w elfare agent 4	0.388%	1.471%	5.341%	-0.010%	0.052%	-0.147%
Terminal capital stock	3.802%	-26.164%	-3.717%	-2.193%	-1.171%	-1.660%
Cumulated Govt. revenue from PEMEX	1.017%	1.678%	-6.376%	0.680%	4.730%	0.358%
Cumulated Govt. revenue from CFE	-4.651%	-2.439%	24.390%	0.200%	2.326%	0.000%
Cum. Govt revenue from other sources	0.498%	-3.229%	51.464%	-1.341%	-1.425%	-1.123%
CO2 Emissions, percent change	12.266%	-36.704%	-12.429%	-13.964%	-22.992%	-13.465%

Scenario7 is compared to Scenario4.

Scenario8 is compared to Scenario7.

Scenario9 is compared to Scenario7.

Scenario10 is compared to Scenario4.

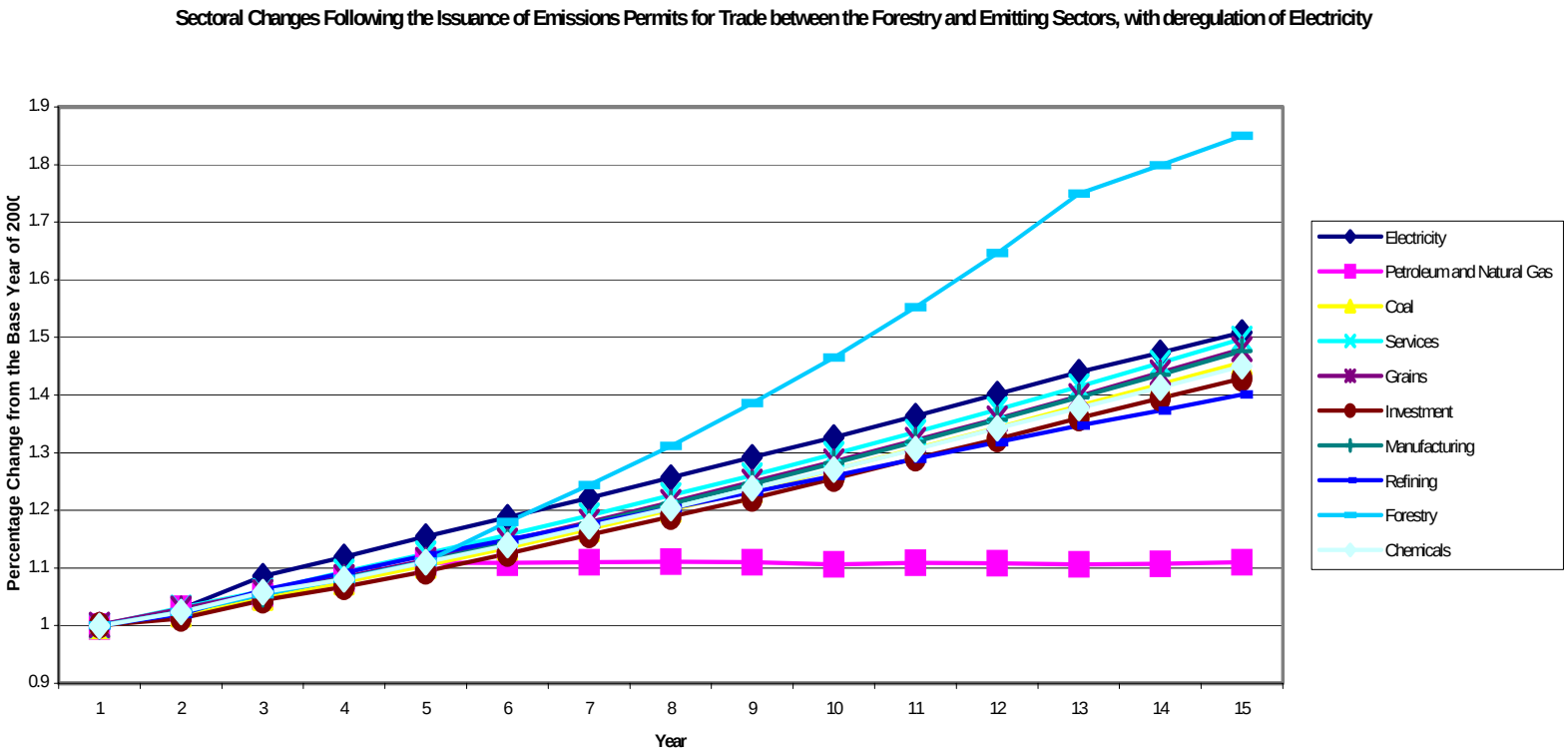
Scenario11 is compared to Scenario10.

Scenario12 is compared to Scenario9.

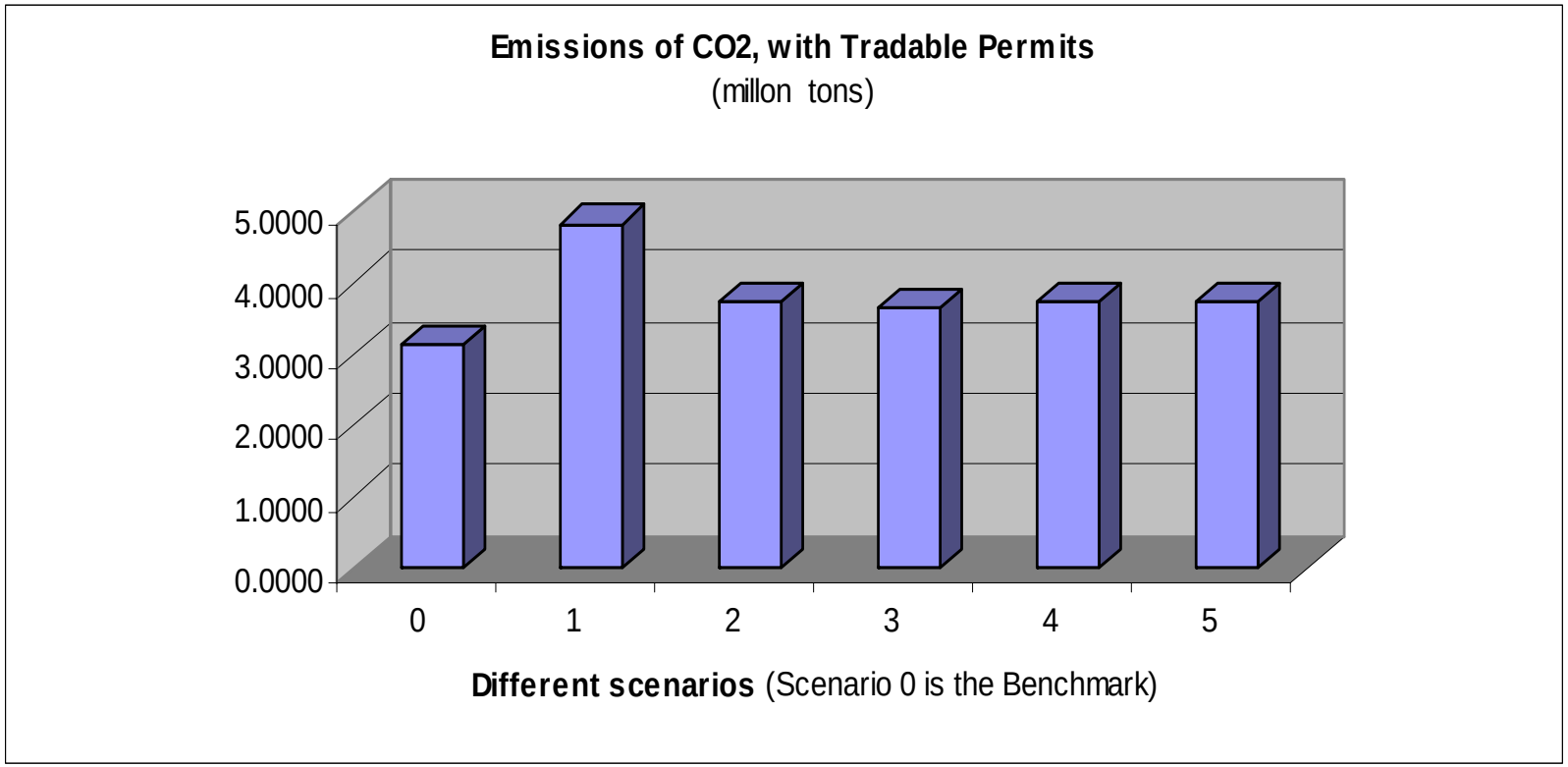
Main conclusions: Emissions Trading

- Domestic trade
  - Trading reduces emissions from manufacturing and chemicals, but not for electricity
  - Substitution towards services: increase in electricity use
  - Pair emissions trading with electricity deregulation (eliminate subsides)
- International trade: work in progress

Sector effects after trading between forestry and manufacturing



Emissions under Permit Trading



Conclusions and Discussion

- Conclusions for Mexico
  - Analysis and comparisson of policies
  - Tool for negotiations
- Discussion of likely results for Brazil, Argentina, and Venezuela

Users of the Book

- Natural resource/environmental economics
  - Chapters 2, 3, 4, 5, 7, 8, and 9
- Development economics
  - Chapters 3, 4, 5, and 9
- Economic modelling
  - Chapters 6, 7, 8, and 9